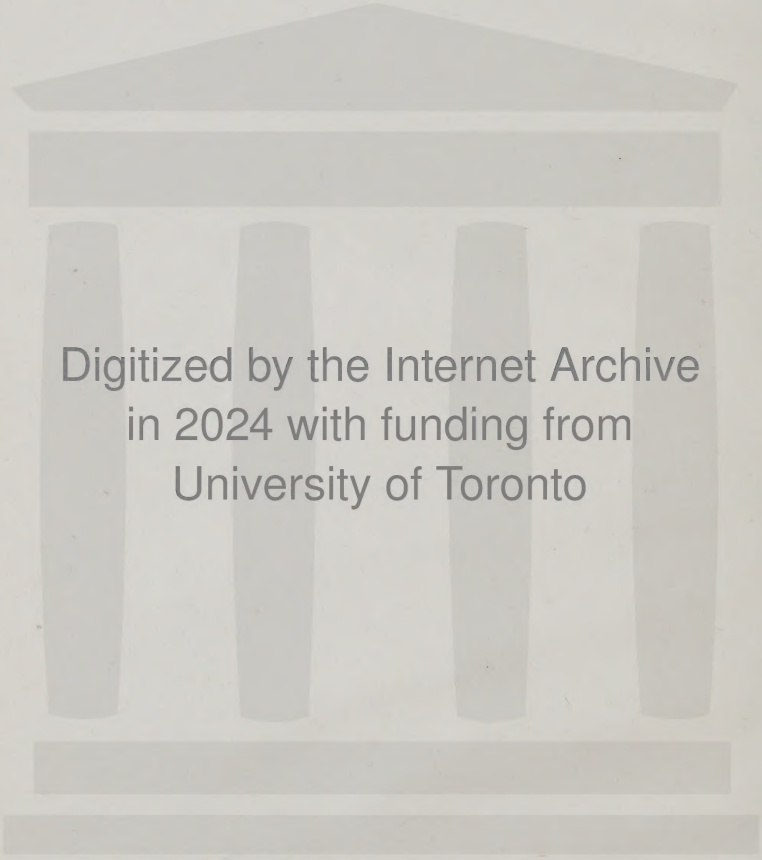

APPENDIX TO THE REPORT OF THE MINISTER OF AGRICULTURE

INTERIM REPORT

OF THE

EXPERIMENTAL FARMS

COVERING THE PERIOD FROM

DECEMBER 1, 1905, TO MARCH 31, 1906

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1906

[No. 16—1907.]

APPENDIX

TO THE

REPORT OF THE MINISTER OF AGRICULTURE

ON

EXPERIMENTAL FARMS

OTTAWA, March 31, 1906.

SIR,—I beg to submit for your approval an interim report for the four months from December 1, 1905, to March 31, 1906, on the work in progress at the several experimental farms.

This report rendered necessary by the change recently made by parliament in the date of the closing of the fiscal year covers a period when outside farm operations are nearly suspended, and when the energies of the farm staff are largely devoted to correspondence with farmers, the attending of agricultural meetings in different parts of the Dominion, and in preparatory work for the approaching spring.

Under these circumstances it has been thought best to devote a considerable portion of the space available in this report to a review of past work and the presentation of some facts regarding the progress of agriculture in Canada since the experimental farms were established.

I have the honour to be, sir
Your obedient servant,
WM. SAUNDERS,
Director of Experimental Farms.

To the Honourable
The Minister of Agriculture,
Ottawa.

INTERIM REPORT

OF THE

EXPERIMENTAL FARMS

COVERING THE PERIOD FROM DECEMBER 1, 1905, TO MARCH 31, 1906.

REPORT OF THE DIRECTOR

WM. SAUNDERS, C.M.G., LL.D., F.R.S.C., F.L.S.

In presenting this interim report covering a period of four months only,—rendered necessary on account of the altering by parliament of the date of closing of the financial year from June 30 to March 31,—it has been thought best to briefly review the condition of agriculture in Canada at the time the experimental farms were established and devote the space available chiefly to those portions of the work which have engaged the attention of the officers of the farms, during the past twenty years and which seem to have more immediate and practical bearing on farm life.

The system of experimental farms established by the Dominion Government for the benefit of Canadian farmers was organized during the later months of 1886. The Act giving the government the authority for the establishment of these farms was passed almost unanimously in February of that year. The general popularity of this measure was no doubt largely due to the strong feeling pervading the community that such institutions were absolutely necessary to the prosperity of agriculture in Canada.

There is probably no country in the world where nature has been more lavish in the stores of fertility provided in the soil, or where the land has greater capacity for the production of food for mankind than Canada. While the resources of the Dominion in its minerals, its forests and its fisheries are very great, it is in the soil that the greater wealth of the country lies. The immensity of the area of fertile land in Canada is very imperfectly understood, even by those who have travelled through the country, and but a very small proportion of the arable land has yet been brought under cultivation.

The climatic conditions in Canada are very dissimilar in different parts and are not favourable everywhere to the production of the same crops. Very large areas, particularly in the great plains of Manitoba, Saskatchewan and Alberta, are well adapted for the production of cereals, especially of wheat of the highest quality. In other and more limited districts conditions prevail which are very suitable for the growing of fruits. Nearly all the arable lands of the Dominion offer advantages for mixed farming, for the growing of different sorts of grain, grasses, roots and other forage crops and for the raising of cattle, horses, swine, sheep and poultry, and for the production of butter and cheese. About one-half of the entire population is engaged in

agricultural pursuits, but the people as yet are comparatively few and the area of unoccupied land is so large that no adequate conception can yet be formed as to the vast quantities of food products which Canada could produce were its inhabitants at all proportionate to its resources.

Under such conditions, the fostering and developing of the agricultural interests of the country are of pre-eminent importance to all classes of the people.

MOVEMENT LOOKING TO THE IMPROVEMENT OF AGRICULTURE.

The subject of the improvement of agriculture was brought prominently before the people of Canada in 1884 when the House of Commons appointed a Select Committee to inquire into the best means of developing and encouraging the agricultural interests of this country. This committee made a careful inquiry into the subject, also as to the disadvantages and wants experienced by farmers in Canada, taking evidence from many persons having experience or scientific knowledge bearing on this subject. From the report of this committee subsequently submitted we learn that in the cultivation in Canada at that time of cereals, grasses and roots, there was very little attention paid to the proper rotation of crops, to the selection of improved varieties, or to the thorough tillage of the soil. There was very little knowledge among farmers as to the value and suitability of manures, and their usefulness in supplying fertility to the land was unheeded and much fertlizing power was lost from negligent exposure of the material.

Very little attention was paid to the improvement of stock, to the selection of milch cows or to the character and condition of pastures. In the making of butter and cheese the quality of these products was inferior, due to want of skill in their manufacture and the lack of improved appliances. In all the branches of agricultural and horticultural work there was a deplorable want of knowledge.

The committee recommended that the government establish an experimental farm or farms where experiments might be carried on in connection with all branches of agriculture and horticulture, and that the results of the work conducted should be published from time to time and disseminated fully among the farmers of the Dominion for their information. No action was taken on this matter until November, 1885, when on the accession of the Honourable (now Sir) John Carling to the position of Minister of Agriculture for the Dominion, he instituted measures for the gathering of further information regarding experimental stations then in operation in Europe and America, and the methods pursued by them in their efforts to obtain information valuable and helpful to the farmers, so that the fullest data might be available and the experimental farms so much needed established on the most approved plans without further delay.

ESTABLISHMENT OF EXPERIMENTAL FARMS.

The Act already referred to as passed in February, 1886, provided for the establishment of a Central Experimental Farm and four branch farms. The central farm was to be located at or near the capital, Ottawa, where it was to serve the purposes of the two larger provinces, Ontario and Quebec. The branch farms were to be distributed as follows, one for the maritime provinces jointly, one for the province of Manitoba, one for the Northwest Territories and one for British Columbia. The work to be undertaken at these several experimental farms was duly set forth in the Act, and covered many of the most important lines of experiments in agriculture, horticulture and arboriculture.

Within two years the land for the several farms was secured, the necessary officers appointed, most of the buildings erected and the farms put in practical operation. The central farm was located near Ottawa, the branch farm for the three eastern provinces at Nappan, Nova Scotia, that for Manitoba at Brandon, the farm for the

Northwest Territories at Indian Head, in Saskatchewan, and that for British Columbia at Agassiz, in the coast climate of that province.

In the choosing of these sites the purpose in view was to have them fairly representative of the larger settled areas in the provinces or territories in which they were placed both as to soil and climate. In the arrangement of the work, such experiments as were most likely to be beneficial to the larger number of settlers were in each case among the first to engage the attention of the officers in charge.

Nearly twenty years have passed since this work was begun, and during that time agriculture in Canada has made unprecedented advancement. It is not claimed that this progress has been wholly due to the influence and work of the Dominion experimental farms. Much credit in this respect should be given to the various measures carried on by other useful organizations established mainly by the several provinces. Foremost among these is the Ontario College of Agriculture at Guelph, which is a well equipped institution which has done noble work. Farmers' institutes and agricultural circles, dairy associations, live stock associations, fruit growers' associations and agricultural and horticultural societies have all been efficient helpers in this good cause. The commissioner's branch of the Dominion Department of Agriculture has also been an important factor. There is, however, no doubt that the experimental farms established by the federal governent have contributed in large measure to the general upbuilding of agriculture in Canada. The progress referred to has resulted in a general improvement in the condition of the agricultural population all over the country, and in a vast increase in the exports of agricultural products.

There is probably no employment which engages man's attention that requires more skill and more general information to carry it on than farming. Competition is keen throughout the civilized world, and the farmer must turn to practical account every advantage within his reach, bearing on improvement in the quality of his products and in lessening the cost of their production, if he is to maintain and improve his position. Investigations involving much experimental research have been conducted along almost every line bearing on agriculture, and a great mass of important facts has been accumulated and given to the farming community in reports and bulletins.

EXPERIMENTAL FARMS BUREAUS OF INFORMATION.

Before the Experimental Farms were established there was no place to which the farmer could apply for information to aid him in the solution of the many difficulties which present themselves during the progress of farm work. When these farms were planned, it was arranged that they should become bureaus of information available to every farmer. Evidence of their usefulness in this way is furnished in the rapid increase in the correspondence carried on with farmers in all parts of the Dominion. In 1889, the year after the farms had become fairly organized, the number of letters received was in all about 8,000. Within five years they had increased to over 25,000, and during the past seven years the average number received annually at all the experimental farms was 68,797. In addition an average of about 300,000 reports, bulletins, &c., have been sent out each year. There is thus a constant flow of information going to Canadian farmers from all the experimental farms.

It is, as a rule, a difficult matter to bring about rapid changes in the ideas and practice of farmers, but as soon as they are convinced that experimental work with the crops they are growing is carried on in a practical manner by persons competent to give information, and that such work is undertaken in their interest, and with the special object of making farming more profitable, their sympathy and co-operation are assured.

The experimental work which has been done at the Dominion Experimental Farms since their organization covers so large a field that it would be impossible to present it in the limited space afforded by this report in anything like a complete manner. We shall, however, endeavour to refer to some of the more important lines of investigation which have been carried on in this large field of labour.

PRINCIPLES WHICH UNDERLIE SUCCESSFUL CROP GROWING.

The principles which underlie successful crop growing may be thus summarized: Maintaining the fertility of the soil, the adoption of a judicious system of rotation of crops, following the best methods of preparing the land, the selection of plump and well ripened seed, early sowing and choosing the best and most productive varieties. Along all these lines many experiments have been conducted, under the different climatic influences which prevail where the several experimental farms have been located. Continued efforts have been made to gain knowledge as to the best methods of maintaining and adding to the fertility of the land.

MAINTAINING THE FERTILITY OF THE SOIL.

In this connection, special attention has been given to investigations to determine the best methods of handling and using barnyard manure, the universal fertilizer which is everywhere more or less available to the farmer. Experiments continued for eighteen years in succession with all the more important farm crops have shown that a given weight of manure taken fresh from the barnyard is equal in crop-producing power to the same weight of rotted manure. It has also been shown by repeated tests that fresh manure loses in the process of rotting from fifty to sixty per cent of its weight. The effective use of barnyard manure so as to obtain the best results with the least waste is without doubt one of the most important problems connected with successful agriculture, for on this material the farmer's hopes of maintaining the fertility of his land, and thus providing for a succession of good crops, are mainly based. It is estimated that the manure produced in the solid and liquid excreta of animals in Canada amounts to about 100 millions of tons per annum. The financial loss involved in the wasteful handling of so large an amount of valuable fertilizing material should impress every farmer with the importance of this subject.

Similar tests have been conducted for the same period with artificial manures to gain information as to their relative value when used separately or in combination on nearly all the more important farm crops. The results obtained from artificial fertilizers used alone have been less satisfactory than those had from barnyard manure, even when the fertilizer has been complete, that is, when it has contained in combination all the more important elements required for plant growth. Better results were expected considering the large proportion of available plant food which such fertilizers contain. The reason why artificial fertilizers show a less crop-producing power than barnyard manure lies probably in the fact that they contain no humus, and that the proportion of vegetable matter in the soil has been much reduced by frequent cropping, and the capacity of the soil for holding moisture lessened to the detriment of its crop-producing power.

RESULTS OF TESTS CONDUCTED WITH DIFFERENT FERTILIZERS.

Tests have been made with many different sorts of fertilizers on spring wheat, barley, oats, Indian corn, field roots and potatoes, and full particulars of these experiments covering 105 plots of one tenth acre each have been published each year in the Annual Report of the Experimental Farms, beginning in 1893, when the average of the results of the first five years was given.

In the experiments with fertilizers on spring wheat the best results have been had from the use of barnyard manure in its fresh condition. This has given an average from 18 successive crops grown on the same land of 22 bushels, 46 lbs. of grain per acre, with 3,969 lbs. of straw. The two unfertilized plots in this series have given an average during the same period of 11 bushels, 14 lbs. per acre, with 1,892 lbs. of straw. The best result obtained from artificial fertilizers was an average of 15 bushels, 33 lbs. per acre, with 2,658 lbs. of straw.

The heaviest crops of barley have been had from the use of rotted barn-yard manure. This has given an average for 17 years of 37 bushels, 6 lbs. of grain per

acre, with 3,042 lbs. of straw, while the same weight of fresh manure has given for the same period 37 bushels 4 lbs. of grain, with 3,187 lbs. of straw. The best result obtained from the use of artificial fertilizers was 28 bushels, 42 lbs. of grain per acre, with 2,382 lbs. of straw. One of the plots devoted to barley has been treated with common salt only, in the proportion of 300 lbs. per acre each year. This has given an average crop of 28 bushels 7 lbs. of grain per acre with an average of 1,890 lbs. of straw, while the two plots in this series on which this crop has been grown continuously for 17 years without any fertilizer whatever have given an average of 15 bushels, 6 lbs. of grain and 1,412 lbs. of straw, thus demonstrating the usefulness of salt on a barley crop.

In the growing of oats the heaviest crop has been had from the plot treated with fresh manure. This has given an average from seventeen years of continuous cropping of 56 bushels, 4 lbs. per acre. It has also given the heaviest weight of straw 3,370 lbs. per acre. The best result obtained from the use of artificial fertilizers was an average of 49 bushels, 31 lbs. per acre, with 3,132 lbs. of straw. The two unfertilized plots have averaged 29 bushels, 33½ lbs. of grain and 1,608 lbs. of straw.

With Indian corn cut green for ensilage rotted manure has given the heaviest crops. This, with continuous cropping for 14 years, has given an average of 16 tons, 1,076 lbs. per acre, while the plot to which fresh manure has been applied has given 16 tons, 809 lbs. per acre. With this crop artificial fertilizers have succeeded well, the best results being an average of 16 tons, 545 lbs. per acre. The unfertilized plots have given an average of 9 tons, 72 lbs. per acre.

In the growing of mangels the rotted manure has given an average in continuous cropping for 14 years of 22 tons, 358 lbs., while the fresh manure has given for the same period, 21 tons, 423 lbs. The best result obtained from artificial fertilizers was an average for 14 years of 15 tons, 214 lbs. The two unfertilized plots have given an average for the same period of 8 tons, 434 lbs. per acre.

With turnips the advantage has been with the plot treated with fresh manure, this having given an average for 14 years of 15 tons, 1,467 lbs. of roots per acre, while that to which the rotted manure was applied gave an average of 15 tons, 1,397 lbs. per acre. The best result had with the artificial fertilizers with turnips was an average of 12 tons, 299 lbs. The two unfertilized plots gave an average of 7 tons, 837 lbs.

CLOVER AS A FERTILIZER.

The ploughing under of clover has been most effective as an additional source of fertility, as it increases the store of available plant food by the addition of nitrogen taken directly from the atmosphere. The experiments undertaken by the experimental farms to demonstrate the value of clover for this purpose were begun in 1894 and have been continued up to the present time. The clover has been sown in the spring with wheat, barley or oats, in the proportion of about 10 lbs. of clover seed to the acre. This has almost invariably resulted in a good stand of clover before the close of the season, as it grows rapidly after the grain is harvested. If it is intended to use the land for growing spring grain the following season, the clover is ploughed under about the middle of October, but if the land is to be used for growing potatoes or Indian corn, the clover is left until the following spring, when by the second or third week in May it will have made a heavy growth and will furnish a large amount of material for turning under.

In addition to the nitrogen collected by the clover it also adds to the mineral plant foods available by gathering these from depths in the soil not reached by the shallower root systems of other farm crops. It also serves as a catch crop during the autumn months, retaining fertilizing material brought down by the rain, much of which would otherwise be lost. It also supplies the soil with a large addition of humus whereby the land is made more retentive of moisture, and results in a deepening and mellowing of the soil. Humus also furnishes material in which those minute forms of life which act beneficially on the soil can thrive and propagate freely.

In a series of experiments with 14 plots of oats, covering a period of five years where clover was sown and ploughed under on alternate plots, those with clover gave an average increased yield of grain of about nine bushels per acre, with a considerable increase in the weight of straw when compared with those plots alongside on which no clover had been sown. When these same plots were sown with barley the following season, the average increase was about eight bushels of that grain per acre. Thus the ploughing under of a single crop of clover showed a large increase in the oat crop the first year both in grain and straw, and almost as large an increase the second year in the case of the barley.

In 18 experiments conducted with Indian corn on plots on which clover had been grown, with alternate plots alongside on which no clover had been sown, the average gain in weight of green corn cut for ensilage was 3 tons 1,694 lbs. per acre. In a similar series of plots on which potatoes were planted an average gain was had of 33 bushels, 20 lbs. per acre. Some experiments have been made by sowing crops on some of these plots the third year after clover had been ploughed under when the results showed a diminished but still a decided increase.

These results have been presented very fully to the farmers of the Dominion in the annual reports of the experimental farms and also in special bulletins, and now the practice is quite common to sow clover with spring grain and turn it under late in the autumn with the object of adding to the fertility of the fields.

THE ROTATION OF CROPS.

Much more attention has been paid of late than formerly to the systematic rotation of crops. Such a course it is claimed economises the use of the plant food in the soil, since different crops take the elements of fertility from the land in different proportions, hence a rotation helps to maintain a balance. Rotations of four and five years are perhaps the most common, barnyard manure being applied with a hoed crop the first year, such as field roots, potatoes or corn. Such crops require frequent cultivation which eradicates any weeds which may be added to the soil with the manure and the land is left in good condition for grain. If a four year rotation is followed clover and timothy are usually sown with the grain the second year, a crop of hay taken off the third year, and the fourth year the field is used as pasture and during the following winter is manured and the sod with the coating of manure placed on it turned under the following spring and the four years' course begun again with the hoed crop.

Many experiments in connection with rotation have been tried on the several branch farms also on the Central Experimental Farm. Fuller reference to these latter will be found in the present report in that part written by the Agriculturist.

THE PREPARATION OF THE SOIL.

In preparing land for crops different methods are adopted in different parts of the Dominion. In the eastern provinces, the fall ploughing of land is now generally followed, as crops can be sown earlier in the spring by the adoption of this plan. On the Northwest plains it has been found an advantage to summer-fallow a portion of the land under cultivation each year. This practice conserves moisture, destroys weeds, and brings the farmer much larger crops. The yield of wheat on land which has been summer-fallowed will usually average one-third more than it will on land which has been prepared by fall or spring ploughing.

IMPORTANCE OF EARLY SOWING.

That increased crops result from early sowing has been fully demonstrated by the tests carried on at the Central Experimental Farm. Experiments with early, medium and late sowings were conducted for ten years on plots of one-tenth acre each, sowing two varieties each year of wheat, barley, oats and peas. The land was very uniform

and all the plots were similarly prepared. Six sowings were made in each case, the first at the earliest time practicable, the second at the end of a week and others at the end of each subsequent week until six successive sowings had been made. These plots were all harvested and threshed separately, and the results recorded. The best crops were had from the second sowings, made just one week after it was possible to get on the land; beyond this delay has resulted in loss, which has become more serious as the delay has been greater. The average of the ten years experiments shows that with spring wheat a delay of one week after the period named has entailed a loss of over thirty per cent, two weeks forty per cent, three weeks nearly fifty per cent and four weeks fifty-six per cent of the crop.

With oats a delay of one week has caused an average loss of over fifteen per cent, two weeks, twenty-seven per cent, three weeks thirty-two per cent and four weeks forty-eight per cent.

In the case of barley a delay of one week has resulted in a loss of twenty-three per cent, two weeks twenty-seven per cent, three weeks forty per cent, and four weeks forty-six per cent.

With peas a delay of one week caused an average loss of four per cent, two weeks twelve per cent, three weeks, twenty-two per cent, and four weeks thirty per cent.

The results of these experiments have been widely published and farmers in the eastern provinces of Canada now pay general attention to early sowing. The early sowing of grain in the Northwest provinces of Canada has also been shown to be highly profitable to the farmer.

THE SELECTION OF PLUMP SEED.

The selection of plump and well ripened seed for sowing is also a great advantage. In each seed is laid up a store of food to be used by the young plant in the early stages of its growth. In a shrivelled seed the store which can be drawn on is very meagre and the growth under such circumstances is slow, but in a well-developed and plump kernel the supply is abundant and the plant starts out with a degree of vigour which is usually maintained and the resulting crop, all other conditions being equal, is usually satisfactory.

SELECTION OF THE BEST AND MOST PRODUCTIVE VARIETIES.

Another important consideration in connection with successful farming is the selection of the best varieties of seed for sowing, taking into consideration productiveness, quality and earliness of maturing. That there are varieties more productive, of higher quality or earlier in ripening than others has been abundantly proven, and the object in view in experimental work along this line has been to introduce or to produce varieties which combine these good qualities in the highest degree.

As to productiveness, a quality of the highest practical importance, in the tests conducted at the Experimental Farms, the variation in different varieties has been very great. In plots of oats adjoining each other and all sown on the same day, the yield has ranged from 89 to 42 bushels per acre. In spring wheat under similar conditions from 31 to 16 bushels, and in barley from 58 to 33 bushels per acre. The experiments carried on have shown also that this productiveness is in a large degree persistent. During a five years' trial 41 varieties of oats were sown every season at the same time and on adjoining plots. Each year a select list was published of the twelve heaviest yielding sorts. During the whole of the five years only 15 of the 41 varieties found their way into the select list, and 9 of these appeared among the best 12 sorts every year.

Of spring wheat, 31 varieties were under trial for a like period. In this case 16 only of the 31 sorts have appeared among the twelve best yielding sorts during the five years' test. The evidence obtained as to the persistent productiveness of certain varieties of barley is also very striking.

The importance of growing such varieties as will give the largest crops is manifest when we consider the very large areas under crop in Canada. An increase of a single bushel per acre in the oat crop alone would add to the annual profits of Canadian farmers nearly two millions of dollars, while a similar addition to the wheat crop would amount to nearly double that sum.

The question may be asked, how can farmers procure these prolific strains of seed? The following is the method pursued at the experimental farms. After careful and continued experiments have shown that any variety is especially productive and promising, this is cultivated in large fields so as to admit of the free distribution of samples among the farmers of the Dominion. The grain for this purpose is grown chiefly at the branch experimental farms in the Northwest provinces and forwarded to the Central Experimental Farm at Ottawa, where most of the samples are distributed and where they can be sent free through the mail. They are sent out in strong cotton bags containing in the case of wheat and barley five pounds, and of oats four pounds, sufficient in each case to sow one-twentieth of an acre. These samples are sent only on personal application, and only one variety can be had by an applicant each year. The interest felt in this distribution is steadily increasing and the general introduction of these high-class farm products into all parts of the country has resulted in improved quality and increased quantity of the crops grown both for export and home consumption.

The grain sent out is not only of high quality but is thoroughly clean, and if a farmer takes reasonable care of the sample he receives, he can soon have sufficient seed to sow a large area for himself, and have a surplus to sell to his neighbours. As examples of reports received from farmers on this point regarding oats, the following will serve as illustrations:—

'The sample bag of 4 pounds of oats sent me two years ago gave me the first year 5 bushels. This year we sowed these on two acres and we got 217 bushels.' 'We got a sample of oats from you six years ago, and they gave us great satisfaction. The people about here think very highly of them and there are thousands of bushels of them grown. The farmers are coming here for seed for twenty miles around.'

'The oats I got from the experimental farm some years ago have been worth a great deal of money to me in increased yield and increased price, as I have sold quite a quantity for seed.'

'The oats of which a sample was received three years ago, proved an excellent variety. I had 420 bushels last year. They yielded 74 bushels to the acre.'

Many similar appreciative letters might be quoted in regard to samples of wheat, oats, barley, &c.

It is thus apparent that with attention and care any farmer may in a very few years provide himself under this liberal arrangement with the best and most productive strains of seed, in sufficient quantities for a large area at no cost to himself beyond that of his own labour.

It is remarkable how rapidly a supply of grain may be built up from a single four or five-pound sample. Take, for example, a four-pound sample of oats. This with ordinary care will usually produce on the average about four bushels. This sown the next season on two acres of land will, at a very moderate estimate, give a hundred and sometimes upwards of 200 bushels. Taking the lower figure as the basis for this calculation the crop at the end of the second year would be sufficient to sow fifty acres, which at the same moderate computation would furnish 2,500 bushels as available for seed or sale at the end of the third year.

The critical point in these tests is the threshing of the grain at the end of the first season, and it is here that many fail to get the full advantage open to them. The product of the one-twentieth of an acre plot which the 4-pound sample has produced is frequently threshed with a large machine which it is difficult to get thoroughly clean, and in this way the grain becomes mixed with other varieties and is practically ruined. At the experimental farms we thresh the product from many of the small plots of grain, by cutting off the heads, placing them in a sack and repeatedly beating

them with a stick and winnowing until most of the chaff is got rid of and the grain made clean enough for sowing. Where the farmer is to use this seed for his own sowing it is not necessary that the sample be absolutely free from chaff, it is, however, most essential that the grain be kept free from all admixture with other sorts.

Farmers are expected to harvest the product of their experimental plot separately and store it away carefully, threshing the product by hand, either with a flail or in such other manner as they may prefer. Cutting off the heads and placing them in sacks may be a convenient method of harvesting in some cases; the results to be gained will abundantly repay the careful handling of this first crop.

It is surprising how rapid has been the growth of the demand for these samples for seed. The number sent out for the first year was 1,149, the second year it was 2,150, and the third year 2,760. By this time the work of the farms had become more generally known and appreciated. A larger number of farmers were made aware of the advantages awaiting them in these pure varieties of improved seed, and in 1890, the fourth year of the existence of the farms, 15,532 applicants were furnished with desired samples of seed. From this time onward the growth was constant, and in 1895 the number reached was 30,553. For the past 10 years the average annual output has been 38,280 sample bags requiring from 75 to 80 tons of choice seed annually. During the spring of 1905, more than 42,000 farmers worked in this co-operative test, and during the past season the number has increased to over 45,000. No such gigantic and practical co-operative work for the improvement of the more important farm crops has ever been attempted before. Canadian farmers everywhere have gladly joined in this important work, and the benefit to Canadian agriculture has been enormous. In almost every part of the Dominion the results of this work are manifest.

For four years (from 1899 to 1902 inclusive) the experiment was tried of sending to a select list of farmers, a few in each agricultural constituency in the Dominion, a double quantity of seed so that each might have enough for the sowing of one-tenth of an acre. During this period more than 12,500 such samples were sent out; but it was found impracticable to continue to send these larger samples to all who applied for them, and as some dissatisfaction was felt among those who were unable to obtain the larger quantities it was thought best to discontinue this special privilege and henceforward to treat all applicants alike. Furthermore, every season after the regular distribution of 4 and 5-lb. samples has been provided for, the surplus grain not required for seed at the North-western experimental farms, is sold to farmers for seed purposes in quantities of from 2 to 10 bushels to each. In this way during the past two years, 245 farmers have been supplied with these larger lots of grain from the branch experimental farm at Indian Head, and 211 from the branch experimental farm at Brandon, or 456 in all. Where these larger quantities of grain are supplied, they are sold to the farmers at a small advance on the ordinary price of grain at the time so as to cover cost of extra cleaning. The increase observed of late in the yearly average of cereal crops in Canada, which is quite considerable, is no doubt due in large measure to the more general cultivation of highly productive varieties brought about by these annual distributions.

NEED OF EARLY RIPENING VARIETIES OF GRAIN.

The season for growth of crops in Canada is short, hence from the outset the importance of securing early ripening varieties of cereals of high quality and productiveness for test in Canada was fully recognized, and inquiries were promptly made in other countries for such material. The first importation made by the experimental farms—within a few months of their organization—was of an early maturing wheat, claimed to be one of the earliest and best sorts grown in Northern Russia. Of this wheat known as Ladoga, 100 bushels were imported in the spring of 1887, when 667 samples were sent out for trial to leading farmers in Manitoba, the Northwest Territories and other parts of the Dominion. Other varieties of seed wheat were also obtain-

ed and portions of these similarly distributed, bringing the total distribution that year up to 1,149 samples. Twelve hundred pounds of the Ladoga wheat were also distributed among the Indian agencies in the North-west to be sown on the Indian reserves, and a portion was kept to be tested on the experimental farms.

Many other varieties of important farm crops were imported in 1887 from other countries, notably from England, France and Germany. These included 67 varieties of spring wheat, 69 of oats and 31 of barley. There were also brought from Europe to be tested on the experimental farms 245 different sorts of potatoes.

Among the varieties of seed grain secured that year, there were twenty-eight different sorts selected from grain offered for sale at the Corn Exchange in London, England, and among these there were several varieties of wheat from India. These proved to be unexpectedly early in ripening. Subsequently it was learned that there were wheats grown in the higher altitudes in the Himalaya mountains, which on account of their early ripening habit were likely to be of value to Canada. Correspondence was opened with the government of India, and through the kind interest taken in this subject by the late Lord Dufferin, who was then Viceroy, there was got together from different parts of India, by the directors of agriculture in the several provinces, a large collection of different sorts of cereals likely to be useful for experimental cultivation in Canada. These consisted of wheat, barley, buckwheat, millet and pulse. Some of the wheats were obtained from crops grown on the plains, others from different elevations in the mountains, some as high as 11,000 feet. Barleys also were had from similar localities.

When received these samples were cleaned and distributed for test among the several experimental farms. Many of the cereals were early in ripening, and some were of excellent quality, but none of them was as productive as the best sorts which were then growing in this country. After five or six years of trial it was not found possible to make these wheats produce crops at all equal in volume to the best of those at present growing here, and for this reason the cultivation of most of them was gradually given up, but not before a number of crosses had been made of the earliest of the Indian wheats with the more vigorous and productive sorts grown in Canada.

IMPROVEMENT IN SEED GRAIN IN CANADA.

Improvement in the quality and character of the seed grain used in Canada has been brought about by—

1st. The introduction of promising varieties grown in other countries.

2nd. By the improvement of existing sorts by judicious selection.

3rd. By the production of new varieties by cross-fertilization and subsequent selection of the most promising types.

The first source of improvement has already been referred to as far as some of the earlier importations are concerned. This good work has, however, been continued from year to year, and from almost every grain-growing country in the world some new varieties have been obtained for test. Many new cross-bred sorts have been brought from Australia, where much original work has been done in this direction. Great care is being taken to maintain and if possible to improve the character and quality of existing sorts by growing considerable quantities of the best of these in a state of purity and distrbuting such for seed among the farmers of Canada; also by judicious selection of such new strains as may from time to time occur in our fields. In Canada we were very fortunate in having generally introduced in our Northwest country, early in its history, so excellent a variety of wheat as the Red Fife. To this we are largely indebted for the high reputation we have obtained throughout the world for the superior quality of the wheat grown in our western country. This good variety has been carefully looked after by the Experimental Farms and large quantities of pure seed have been grown every year and distributed among farmers in the Northwest country, which has been a great help towards keeping this excellent sort in a comparatively pure condition.

The third method referred to by which improvement has been made in the grain grown in Canada is by the cross-fertilizing of different varieties. This has already produced very useful results, and the prospect of further improvement from this line of work is most hopeful and encouraging. The natural variations which occur in varieties and which may be maintained by careful selection are for the most part bounded by narrow limits, but in cross-fertilizing the outlook for variations of a much wider character is practically unlimited, and the number of distinct varieties which may be bred from a single cross is sometimes startling. Many of these after careful testing are found to be lacking in some particular quality desired or are inferior in quality to the parents from which they were produced. All such are promptly discarded, especially those inferior in quality, since quality is most important and must be maintained. Others of promise have been retained for further trial, and the aim in all this work is to produce cereals equal in quality and productiveness with the best varieties now in cultivation and earlier in ripening. It is also desired to have these good qualities combined with stiffness of straw and more or less immunity from rust. Varieties have already been produced superior in some of these particulars, but not in all. Some of the cross-bred wheats in a ten-years' trial have proved more productive than Red Fife and have ripened a week earlier. Other varieties have a higher proportion of proteids, and hence would probably be more nutritive. A variety has been produced with nearly fifty per cent more protein than Red Fife. Others have been obtained which ripened two to three weeks earlier than Red Fife. In most cases extreme earliness has been associated with a somewhat lessened crop. Indeed, it is only reasonable that such should be the case. Where a grain has such an early ripening tendency, it is hurried along by the forces of nature so rapidly that it has not time to store in the fast ripening head kernels so plump as in the case of a slower ripening sort, and it is not unlikely that it may be exceedingly difficult, if not impossible, to combine all these good qualities in the highest degree in any single variety, but the interests involved are so great that the possibility of its attainment should prove a stimulus to unceasing work in this direction.

A variety which ripens two or three weeks earlier than others will admit of being cultivated probably several hundred miles further north, and thus the area of wheat-growing may be greatly extended and the loss of some part of the volume of crop will be more than made up by the results obtained from earliness in ripening. A wheat in which is found on analysis an increase of 50 per cent in nitrogen, even if the quality of the nitrogenous compounds are inferior for bread-making, may prove invaluable for the fattening of stock. Where advances are secured in any direction such vantage points are held and further improvements are attempted by fresh combinations using these improved forms as starting points.

WORK OF THE CEREALIST.

During the first few years after the Experimental Farms were established this interesting work was carried on by the writer. Subsequently much help was rendered by competent assistants. Recently cereal breeding and selection at the Experimental Farms has been made a special division, with a trained and competent officer in charge, and under this arrangement much more progress is being made than was possible formerly. The varieties in cultivation are being improved in quality and purified by careful selection, and a large number of new sorts are placed under test each year. For further particulars of the work of this division, the reader is referred to the report of the cerealist.

After careful and continued experiments have shown that any cereal is specially promising, such variety is cultivated on a large scale so as to admit of its free distribution for test among farmers in different parts of the Dominion.

AGRICULTURAL WORK.

The object lessons which have been given in the raising of fodder crops and converting them into hay or into ensilage and thus providing succulent food for cattle during the winter months, have given a stimulus to the dairy industry, especially to the making of butter. It has also promoted the work of the fattening of steers, and such industries have afforded profitable employment for farm labour during the winter months. The experiments which have been conducted with reference to the economical production of butter of the highest quality and the best management of milk to secure the most complete separation of the butter fat have been beneficial to those engaged in this special industry. The experience gained by the experiments tried in the feeding of cattle and swine, with the view of producing the highest quality of beef and pork at the lowest price has stimulated and aided the stock industries. Fuller details in reference to the work of this division will be found in the report of the agriculturist.

HORTICULTURAL WORK.

Many instructive and valuable experiments have been carried on with many varieties of large and small fruits to find out how far these different sorts can be grown with profit in the different climates of the Dominion, and the localities where they can be produced to the greatest advantage. The information thus gained has been very helpful in extending and promoting fruit growing, and has resulted in the more general production of fruits of high quality and in increased exports of these products. The best methods of treatment of orchards have also been tried. New seedling fruits found in different parts of the Dominion have been brought together to be tested and compared, and varieties of merit have been thus introduced into more general cultivation. New sorts have also been produced by cross-fertilization and selection. The experiments carried on in the cultivation of vegetables to find out what varieties are best suited to the different climates of the country have also proved of much value and lists of varieties suitable for cultivation on the farm have been published. Much information has also been gathered in reference to the cultivation of the potato and the best and most productive sorts have been made known. Many details of interest connected with the work of this division will be found in the report of the horticulturist.

DIVISION OF ENTOMOLOGY AND BOTANY.

The practical help which has been rendered by the Division of Entomology and Botany has been a source of much satisfaction to the public. The information given by the officers of this division as to the best remedies for the destruction of noxious insects which often rob the farmer of a large part of his profits has been most useful in lessening the loss which would otherwise have occurred. The benefit derived by treatment recommended for the various fungous diseases from which grain, fruit and other crops occasionally suffer has been much appreciated by farmers and fruit-growers. The subject of noxious weeds has also been fully investigated, and the best measures to adopt for their control and subjugation pointed out. Large collections of Canadian insects and plants have been brought together by the officers of this division, and these collections are turned to good account by entomologists and botanists in different parts of the country who desire to name their specimens.

Many native and foreign grasses have been tested in the large series of plots in charge of this division, and their relative usefulness for fodder, pasturage, and lawns ascertained. Further details in reference to the good work done by this division will be found in the report of the entomologist and botanist.

DIVISION OF CHEMISTRY.

The work of the officers of the Chemical Division has covered a large field. Investigations have been conducted to determine the nutritious constituents in many fodder plants, which have been analysed at different stages in their growth to ascertain the period when these plants may be cut with the greatest advantage. The relative value from the feeding standpoint of the larger number of the native and introduced grasses has also been ascertained.

Many analyses have been made of Canadian grown cereals to ascertain their quality and nutritive value. These have included many sorts of wheat, also oats, barley, emmer, spelt and rye. Analyses have been made of the straw of many of the more important cereals to ascertain their relative value for feeding purposes.

Many investigations have been made as to the proportion of sugar in sugar beets grown in different parts of the Dominion, and of the proportion of nutritive matter contained in other sorts of field roots. Analyses have been made of soils received from different parts of the Dominion, especially such as were representative of large areas. The nature and amounts of fertilizing ingredients in manures have also been studied. Many experiments have been conducted to throw light on the important subject of soil moisture and means suggested whereby desired conditions of moisture may to a great extent be obtained and controlled. Fuller particulars on many such subjects will be found in the report of the chemist.

POULTRY DIVISION.

In the Poultry Division much useful work has also been done. The relative value of the different breeds of fowls has been tested and the superiority shown for farmers' use of the best of the utility breeds. The best methods to adopt in connection with the raising of poultry have been demonstrated, and the best rations for the promotion of egg-laying, also for the fattening of chickens made known. Recent experiments with trap nests have shown great variations in the number of eggs laid by individual fowls of the same age and breed, and it is hoped that by raising chickens from the eggs of the best layers superior laying strains may be established. For fuller particulars the reader is referred to the report of the poultry manager. There is no doubt that the business in eggs and in dressed fowls for the table has been materially advanced by the publication of the results obtained from experiments conducted in the poultry division.

BRANCH EXPERIMENTAL FARMS.

Important series of experiments have also been conducted at each of the branch experimental farms, varying in their nature and character as required by differences in climate, &c. All the best varieties of the more important farm crops have been tested each year side by side at all the experimental farms during the past twelve years. Uniform trial plots have been conducted at each farm for the purpose of gaining information as to the most productive and earliest ripening sorts, of grain, fodder corn, field roots and potatoes. In arranging for these plots the same varieties have been grown at each of the farms, the seed being supplied at the outset from a common stock. In each case the seed has been sown early, and as a rule all the different sorts of the same crop have been sown on the same day or within two days and on soil as uniform in quality as could be found, so as to give to all an even start. A crop bulletin is published at the close of each season giving the results of the test of all these varieties at each of the experimental farms. The particulars published in this

bulletin showing as they do which are the best and most productive sorts, arranged in the order of their merit, do much to influence farmers to make choice of the best varieties, and thus the cultivation of the most productive sorts is rapidly extending.

At the branch farms many experiments have also been conducted in reference to the best methods of preparing the land for crop, also in the testing of the best varieties of cereals, &c., in fields and plots, the proper depth at which seed should be sown and the quantity of seed needed per acre to produce the best results. The value of Indian corn when used as ensilage for the feeding of cattle has been tested and the relative value of the different sorts for his purpose carefully estimated. Indian corn has also been sown in rows at different distances to ascertain which method of treatment would produce the heaviest crops. Many experiments have been conducted with turnips, mangolds, carrots and potatoes to ascertain their suitability as a crop in the different provinces, also the best time for sowing, the best methods of treatment of the land and the most profitable varieties to grow.

Experiments have been conducted with dairy cows to determine their relative capacity to produce milk with a high percentage of butter fat, also in the fattening of steers on such sorts of feed as are most abundant in the different localities where these farms are situated. Their comparative gains on different rations have been shown and the cost per pound of increase in weight. Many tests have also been made with swine to find out how they may be most readily and economically prepared for market.

Experiments in the rotation of crops have also been carried on and the results published in the annual reports of the farms. The relative usefulness of many of the native and foreign grasses for hay and pasture has been studied. Clovers also of different sorts have been the subjects of many experiments. Many trials have also been made with flax, millet, buckwheat, rye and other crops.

Experiments have also been conducted with poultry and with bees.

In the testing of fruits the experiments have covered a large field, all the varieties likely to be useful of both large and small fruits have been tried and their suitability or lack of suitability to each particular climate ascertained. In the eastern provinces and in British Columbia there are large areas of land eminently suitable for the growing of large fruits and many of the small fruits can be successfully cultivated in nearly all the localities where settlements have been made throughout the Dominion. After trials have been made lists of the best and most productive sorts have been published and much information of practical value has been given.

In most parts of the Canadian Northwest, the efforts made to grow the varieties of apples cultivated elsewhere have failed owing to an unfavourable climate. To meet this contingency, new and hardier varieties have been produced by crossing a small, but very hardy Siberian crab known as Pyrus baccata with some of the best sorts of apples grown in Ontario. This work was begun in 1894 and since then more than 1,000 crosses have been produced. A large proportion of those which have fruited have proved inferior; but among them there are twenty varieties which, from their superior size and quality, may be regarded as useful for domestic purposes and deserving of general cultivation in those districts where the standard apples will not grow. These cross-bred apples are now being tested at more than three hundred different points in the Northwest, at altitudes varying from 750 to 4,200 feet, and from accounts received they seem to be quite hardy. The success thus achieved is most encouraging.

THE GROWING OF VEGETABLES, ORNAMENTAL TREES AND FLOWERS.

Many experiments have been conducted with nearly all sorts of garden vegetables, many varieties of the same sort being grown side by side to determine their relative hardiness, earliness in maturing and productiveness. A large number of ornamental trees and shrubs have been tested on each farm and their hardiness and suitability to the different climates of the Dominion ascetained. A number of varieties of flowers

have also been tried, so that the superintendents of the several branch farms might be in a position to give information regarding all these things to the public when required. Much success has attended these experiments, and the flower beds on the several farms are most attractive to visitors during most of the summer and during the autumn the seeds of many of the best sorts are saved and distributed to those who take special interest in the work of home adornment.

TREE PLANTING.

Experiments in tree planting were begun at all the Experimental Farms as soon as practicable after their organization. At the Central Farm twenty acres are devoted to forest experiments to determine the relative growth of the more important timber trees under different conditions. Sixty-five acres of the same farm are used as an arboretum, where trees and shrubs from many countries are under test to determine how far they are suitable for growth in eastern Canada. Smaller areas are devoted to the same purpose on the branch Experimental Farms. As the need for forest shelter on the open plains in the Northwest country is very great, special attention has been given to the encouraging of tree planting for shelter in Manitoba, Saskatchewan and Alberta. From sixty to seventy thousand trees have been planted on the experimental farm at Brandon, and more than one hundred thousand on that at Indian Head, in shelter belts, avenues and hedges, furnishing examples as to the best methods of planting, and at the same time giving information as to the cost of such plantations.

To aid others in starting this useful work, there have been distributed among the settlers during the past eighteen years a vast quantity of young forest trees, with some ten to twelve tons of tree seeds. These have been sent free to all aplicants. The results of this work are now everywhere apparent. On homesteads in almost every part of the Northwest plains there are plantations of forest trees, which afford shelter for buildings and stock as well as for the growing of garden vegetables, small fruits and flowers. Thus the dwellings of the settlers are made more attractive, bare and uninviting surroundings being converted into pleasant, sheltered homes.

DISSEMINATION OF INFORMATION.

Many thousands of farmers visit the Experimental Farms every year to inspect the work in progress, and those who are not able to do this receive, on application, the reports and bulletins issued from the farms, giving an account of the work done and the results achieved.

The officers of all the farms attend meetings of farmers in different parts of the country, where opportunities are afforded of giving fuller explanations concerning all branches of the work in progress.

AGRICULTURAL ADVANCEMENT.

In the meantime the upbuilding of agriculture has progressed rapidly and the occupation of farming has been elevated in the estimation of the community. It is no longer looked upon as a drudgery in which the dull and slow-going may eke out a laborious existence; on the contrary, it is now recognized as a suitable field for the exercise of the higher intelligence of cultivated minds, and as a calling requiring much skill to conduct successfully.

While the demands of the home market for the chief food products are immensely greater than they were twenty years ago, the requirements are fully met, and, at the

same time, the exports of farm products have greatly increased. In wheat, flour, cheese, butter, pork, fat cattle, fruit and many other lines, the increases have been enormous.

With the rapid settlement of the large areas of rich lands now open to settlers in all parts of the country, the food products available for home use and export will rapidly increase in volume, and some of the wealth laid up in the soil will find its way into commerce and enrich the community. There is no pursuit more noble than that of the advanced agriculturist, who endeavours, by the exercise of skill, to improve the condition of his fellow-men, and add to their happiness by making the earth to yield bountifully and to produce food in larger quantity and of better quality, to sustain the teeming millions now occupying the surface of our globe.

REPORT OF THE AGRICULTURIST.

J. H. GRISDALE, B. Agr.

Ottawa, March 31, 1906.

Dr. Wm. Saunders, C.M.G.,
Director Dominion Experimental Farms,
Ottawa, Ont.

Sir,—I have the honour to submit herewith my report for the period of four months from December 1 to March 31, which consists chiefly of a brief review of some of the conclusions drawn or information gained from some of the most important work that has been carried on in this department since the inception of work here in 1887. The amount of work to be considered prevents anything more than bare conclusions or very succinct summaries being presented in the space at my disposal.

I have the honour to be, sir,
Your obedient servant,
J. H. GRISDALE,
Agriculturist.

Results obtained or conclusions reached in field or cultural as well as in live stock work must necessarily be subject to continuous revision. Where factors so varying as soil peculiarities, climatic vagaries and animal individuality are to be reckoned with it is only from the average results of long series of experiments that any really safe conclusions may be drawn. The field work and the live stock work here must therefore be looked upon by farmers seeking for guidance as being approximately rather than absolutely correct. Further, each farmer who would benefit must be prepared to modify methods to suit his own conditions.

SOIL AND SOIL CULTIVATION.

The soil on that part of the Central Experimental Farm devoted to the growing of general farm crops varies from clayey hardpan to yellow sand including black muck or peaty soils of various degrees of peatiness. While such variety of character in the soil adds to its value as an experimental farm area by permitting a study of methods of cultivation and of systems of rotation best suited for the various soils, it also detracts somewhat from the value of most crop growing and cultivation experiments by rendering results always or practically always subject to an uncontrollable and a not easily to be eliminated factor, that is, very varying areas as to character of soil. No two fields, one might even say no two adjacent acres on the farm may be said to be quite similar in character.

Since, however, very few farms consist of soils quite uniform in character, our results obtained on large areas of such varied soils as are included in this farm may be held to be fairly comparable with those obtained on the average farm. Further, since it would be folly for any farmer to try to crop or cultivate according to the varying character of his soil where from 3 to 10 distinct varieties of soil may be found in a 10 acre field, it is evident that any work that goes to determine what system of rotation or cultivation gives the best average results on all soils is of no small value. For the above reasons results obtained here as to cost of crops, amount of labour required for different crops, yields to be anticipated and rotations to be followed may be considered valuable, and even more valuable for the reason that they are average results.

FIELD WORK.

The various lines of work carried on here on the area devoted to field crops may be summarized as follows:—

1. Experiments to determine best methods of growing various crops.
2. Cost of production experiments.
3. Stock bearing capacity of land, 'The 40-acre lot.'
4. 'The 200-acre farm.'
5. Rotations.

On account of lack of space only the very briefest kind of a summary of the conclusions drawn or the results obtained in each line may be given.

1. As to methods of growing crops our work points to the absolute necessity of (1) early seeding, (2) thorough cultivation, (3) sufficient and good seed (4) not growing similar crops many years in succession on same area, (5) barnyard manure, (6) clover as a fertilizer if good results are to be obtained.

2. As to cost of production the average of a few results show the cost per acre of various crops including rent of land at $3 per acre, manure at $3 per acre, manual labour $1.50 per day, teams $3 per day, and single horses $2 per day, to be as follows:—

COST OF PRODUCTION.

Crops.	Cost per Ton of Feed.	Cost per Acre stored ready for Consumption in each case.
	$ cts.	$ cts.
Corn for ensilage	1 50	25 53
Roots	1 69	41 68
Oats	12 03	13 53
Barley	11 95	13 45
Peas	16 51	13 85
Horse beans	2 21	25 16
Rape	0 93	12 71
Pumpkins	1 43	25 50
Hay (average of all sorts of hay)	3 52	9 23
Mixed grain for hay	6 46	16 20
Rye for green feed	3 13	15 65
Sunflower	6 30	23 59

3. An experiment to determine the possibilities in the way of keeping cattle on a given area of land was carried on for five years, from July 8, 1891, to July, 1896. This was known as the 'Forty-acre lot experiment.'

The results obtained show that sufficient food was grown on the forty acres during the course of the experiments to carry stock as follows:—

For the first year, 1891-92 . . . . . 14 cows.
" second year, 1892-93 . . . . . 23 "
" third year, 1893-94 . . . . . (Experiment interrupted)
" fourth year, 1894-95 . . . . . 25 cows.
" fifth year, 1895-96 . . . . . 24 "

The straw used for bedding was not grown on the 'Forty-acre lot.'

4. In 1899 about 200 acres of land was taken to be used as a farm, and a five-year rotation introduced thereon as well as a system of shallow cultivation.

The rotation introduced was as follows:—

1st year.—Hay or pasture ploughed shallow early in August, ridged up into ridges 8 inches high, 2 feet apart in October, subsoil having previously been stirred by means of a stiff toothed cultivator.

2nd year.—Oats or other cereals, 10 lbs. clover sown for fertilizer.

3rd year.—Corn or roots, green barnyard manure applied in winter 15 to 20 tons per acre.

4th year.—Cereal crop, 10 lbs. clover, 12 lbs. timothy.

5th year.—Hay—mostly clover.

The results have been as indicated next page.

The variety of crops grown and the varying areas under each crop each year render it quite difficult to make a comparison of the returns of the different years, so to simplify matters I would suggest that a fixed valuation be put upon the products, and the returns of each year valued accordingly.

Fixing prices as follows : Grain, $1 per hundred lbs.; roots and ensilage $2 per ton; hay $7 per ton; summering cattle, $8 per season; and an area used as pasture for pigs, $15 per acre; the returns from the '200-acre farm' for the years mentioned may be said to have been worth $2,776.66 in 1899; $4,110.21 in 1900; $4,434.72 in 1901; $4,787.14 in 1902; $4,148.19 in 1903; $4,741.09 in 1904; $5,714.32 in 1905.

Rotation Experiments.

5. The results of the work with the 5-year rotation on the 200-acre farm led to the inception in 1904 of an experiment to test the value of different rotations. The 200-acre farm was accordingly divided into 39 different lots of varying size, shape and soil characteristics. These were then grouped as follows :—7 of 3 lots each, 2 of 4 lots each, and 2 of 5 lots each, in addition a bit of rather broken land used for sheep was divided into 4 lots, so making up another group. It was attempted to so select the lots going to make up each group as to include considerable areas of each grade of soil.

Each group was then put under a certain rotation, as follows:—

Rotation A.—Five years, clover hay, timothy hay, grain, corn, grain.

Rotation B.—Five years, clover hay, grain, clover hay, corn, grain.

Rotation E.—Three years, pasture, corn, grain.

Rotation Z.—Three years, clover hay, corn, grain.

Rotation S.—Four years (shallow ploughing), clover hay, timothy hay, roots, grain.

Rotation D.—Four years (deep ploughing), clover hay, timothy hay, roots, grain.

Rotation H.—Three years, hog pasture, roots, grain or soiling crop.

Rotation T.—Four years, sheep pasture, roots and soiling crop, grain clover hay.

Rotation M.—Six years, grain, grain, clover hay, timothy hay for three years.

Rotation N.—Six years, grain, grain, timothy hay for four years.

Rotation O.—Three years, grain, timothy hay, timothy hay.

Rotation P.—Three years, grain, clover hay, timothy hay.

Since this experiment has lasted two years only, it is too early to attempt to draw any conclusions or to summarize.

LIVE STOCK.

Working horses were of course introduced on the farm at a very early date in its history. On the establishment of Le Haras National some stallions were located here, but no breeding operations of any note have ever been carried on.

The breeding work with live stock began in 1889 when some 44 head of cattle were purchased. This purchase included Shorthorns, Ayrshires, Holsteins, Jerseys and Polled Angus. Since 1889 Holsteins, Jerseys and Polled Angus have been dropped from the list, and Guernseys and Canadians added, so that now the herd includes Shorthorns, Ayrshires, Guernseys and Canadians.

TABULATED CROP RESULTS OF ROTATION AND SOIL CULTIVATION WORK ON '200-ACRE FARM,' FROM 1899 TO 1905, INCLUSIVE.

YEAR.	GRAIN.		HAY.		ROOTS AND CORN.		PASTURE.		SOILING CROP.		PIG PASTURE.		REMARKS.
	Area in Acres.	Yield in Pounds.	Area in Acres.	Yield in Tons.	Area in Acres.	Yield in Tons.	Area in Acres	Number of Cattle.	Area in Acres.	Disposition of Crops.	Area in Acres.	Crops Grown for Pasture.	
1899.....	73	118,466	39	93	40	326½	40	36	1	Fed to dairy cows	..	.....	Generally considered a good year for all crops.
1900.....	80	126,621	53	138	40	743	20 and aftermath.	49	....	.....	....	.....	Season very favourable for most crops.
1901.....	79	114,472	58	210	40	702	16 and aftermath.	52	....	.....	...	.....	" " "
1902.....	74	144,914	60	216	39	665	20 and aftermath.	62	....	.....	5	Clover, rape and aftermath.	Season favourable for hay, bad for corn.
1903.....	69	126,619	62	154	34	473	16 and aftermath.	96	5	Dairy cows, bulls and calves.	6	Clover and rape.	Season very unfavourable for most crops, particularly adverse to corn and roots. No second crop hay.
1904.....	67	112,009	60	192	46¾	674	13·75	98	3	" " ..	3	" " ..	Season unfavourable for grain and corn, good for hay and roots.
1905.....	66	111,932	59	258	47	971½	14 and aftermath.	100	5	All cattle ensilage fed.	4	Clover, rape, mixed crop, pease, roots.	Season favourable for hay, corn and roots, too wet for grain on mucky land.

In 1890 pigs were introduced, the breeds represented being Yorkshires, Berkshires, and Essex. Since then several other breeds have been experimented with, but a few years ago it was decided to abandon all but Yorksires, Tamworths and Berkshires, small herds of each breed being at present on hand.

It was not till 1899 that small flocks of sheep were secured. Leicesters and Shropshires were the breeds selected.

HORSES.

As indicated, practically no work in breeding has been carried on with horses. The experimental work has been confined to determining the relative values of different kinds of feed, both rough and concentrated. The results show that not infrequently horses are fed at a greater cost than necessary since a considerable proportion of the grain, usually oats, might be replaced by bran which, generally speaking, costs from 20 to 40 per cent less than oats.

Ensilage and roots (carrots) have been found particularly valuable for idle or lightly worked horses.

CATTLE.

Naturally work with cattle must be divided into (1) beef production and (2) milk production.

Beef Production.

Under this heading some of the work carried on has been along the lines of:—

(1) Breeding.

(2) Testing various feeds as to their value for beef production.

(3) Testing values of rations.

(4) Studying influence of age on cost of beef.

(5) Studying influence of methods of stabling on cost of beef.

(6) Baby beef.

(7) Length of feeding period.

(8) Influence of quality or breeding on possibilities of profit in feeding operations.

(9) Methods of feeding.

1. Our work goes to show that breeding affects very materially the chances of profit from feeding steers. The more typically beef type the breeding stock, the more certain and greater are the profits on the progeny.

2. Practically every available feed, both rough and concentrated, has been experimented with, but space will not permit of giving results save in a general way.

For roughage.—Corn ensilage, mangels and turnips are about equally valuable as the succulent part of the ration; clover hay and alfalfa rank first as dry coarse feeds.

For concentrates.—Corn ranks very high, although gluten meal is probably its equal, mixed meals give excellent results. Oats 100, bran 100, oil meal 100 constitutes a very excellent meal mixture.

3. Much has been done by way of testing the value of various rations for beef production. Not to enter into details it may be said that for a 1,000-lb steer under

full feed the following ration has never been surpassed here either as to palatability or fatting qualities.

	Lbs.
Corn ensilage	50
Roots (turnips)	20
Cut straw (oat)	2
Clover hay (well cured)	6
Bran	2
Corn (ground)	4
Oil meal	2

The ensilage, pulped roots, chopped straw and meal all mixed together and fed in equal portions night and morning, part of the hay following each feed of chopped forage.

4. For a number of years a study of the influence of age on the cost of making gains or increasing the weights of steers has been under investigation. Our experiments show a fairly regular gradation of cost according to age, that is, the older the animal and the longer on feed the more expensive to make a pound of increase in weight.

Average results show :

	Cost per 100 lbs. Increase in live weight.
Steers from birth to 6 months	$2 24
" 6 to 12 months	4 11
" 1 to 2 years	5 49
" 2½ to 3 years	6 17
" 3½ to 4 years	7 98

In the fattening period early gains are always very much more cheaply put on than later gains. First month gains with 3-year-olds are not infrequently made at as low a cost as 4 cents per pound while later gains with the same animal may cost from 15 to 20 cents per pound.

5. Comparing steers fed loose in box stalls with similar steers fed tied in stalls, and making a study of the number that may best be fed together loose in box stalls, our results would indicate that:—

(1) Steers fed in box stalls loose do better than similar steers fed tied on similar feed.

(2) From eight to ten in a box give better results than a larger number. Steers fed loose together must be fairly uniform as to size and quiet as to disposition.

6. Experiments in baby beef production show a decided advantage in getting steers ready for the block at as early an age as possible rather than in letting them go till three or four years old before having them ready to kill. Steers fed here and got ready for the block under two years old have always left a good profit. Steers kept after that age have shown a loss.

7. Experiments in feeding for a long period compared as to profits with feeding for a short period have shown that if roughage be relatively more plentiful and cheaper than meal, then the 'long feed' is the more profitable, but where meal is plentiful and roughage scarce, then the 'short feed' is likely to be the more profitable.

8. Experiments in feeding lots of an inferior class of steer in comparison with lots of a medium class of steer and lots of a superior class of steer go to show that the superior class give greater returns for feed fed, make greater gains in a given time, and sell for a higher price than do the inferior class.

9. Feeding steers twice a day rather than more frequently has been found advisable. Feeding a succulent ration has been found to be cheaper and more wholesome than an all dry feed ration. Mixing roughage and meal seems to give better results than feeding them separately. It is advisable to feed some long hay after each chopped feed portion.

Clipping, dipping or washing steers on entering stables in autumn is profitable. Brushing steers down frequently pays.

DAIRY CATTLE.

Some lines of work conducted with dairy cattle have been as follows:—

1. Breeding.
2. Economy of production of milk.
3. Values of different feeds, both rough and concentrated.
4. Influence of feeds on quality and quantity of milk.
5. Individual records.
6. Influence of hours of milking on quantity and quality of milk.
7 Cost of feeding

1. Work in breeding for milk production here seems to show that: (*a*) superior dairy cows may be found in all breeds. (*b*) Pure bred females are not essential to success in dairy farming, but a pure bred bull should always be used.

2. Cheap milk production is assured by the use of succulent or juicy feeds, such as mangels, sugar beets and ensilage, and nitrogenous or flesh and milk forming feeds such as clover and alfalfa hay, bran, oats and oil meal on well bred stock in well lighted, well ventilated, comfortably bedded stables.

3. Sugar beets probably rank first as a succulent feed, mangels and ensilage being however, very excellent. Bran, oil meal, ground oats, shorts and gluten are the best concentrates.

4. Feeds do not affect the quality of the milk produced so far as percent of fat is concerned, but may affect the flavour of the milk or the character of the butter. They will also affect the total quantity of fat produced in a given time as well as the quantity of milk produced in the same given time.

5. Individual records have been found to be very valuable as a guide in breeding and feeding. Weighing the milk night and morning from each cow serves not only to show what a cow is at the end of the year, but is sure to make each cow do better on the average, for the milker cannot help taking an interest in her record and so do his best by her as to feed and care.

6. Whether milking be performed at equal or unequal intervals does not seem to affect the quantities of either the milk or butterfat yielded by a cow, but does affect the character of the milk after each milking. The smaller quantity and the higher percentage of fat being obtained after the shorter interval. Regularity in hours of milking is essential.

7. Cost of feeding should be carefully studied as our experience shows savings or improvement frequently possible, individuals being often fed too heavy or too light a ration for the milk being produced or that might be produced at a given time.

SHEEP.

Sheep have been kept here for a short time and but little experimental work has been carried on.

SWINE.

Bacon for the English market being the important consideration in pork production, work to determine best methods of breeding and feeding to produce suitable hogs at lowest cost are continually under way.

Since a very full review of this work 'Bacon Pigs in Canada,' Bulletin No. 51, appeared only a few months ago, further remarks thereon seem unnecessary.

REPORT OF THE HORTICULTURIST.

W. T. MACOUN.

OTTAWA, March 31, 1906.

Dr. WM. SAUNDERS, C.M.G.,
Director, Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to submit herewith an interim report of this division In this report will be found a summary of the results of some of the most important experiments conducted by the Horticultural Division, but as few experiments are carried on during the winter months it has been thought best to present at this time a resumé of the more important experiments conducted since 1887, together with an account of other work of this division during the past nineteen years.

I have the honour to be, sir,
Your obedient servant,

W. T. MACOUN,
Horticulturist.

INTRODUCTORY.

The Horticultural Division of the Central Experimental Farm, Ottawa, was organized in the spring of 1887, when experimental work was begun there. Up to that time the experimental work in horticulture which had been done in the provinces of Ontario and Quebec had been confined mainly to unaided individual effort, and too much praise cannot be given to those pioneers of Canadian horticulture who did so much to encourage fruit growing in Canada and who, many of them, to-day are continuing the good work. An experimental orchard had been established by the provincial government in connection with the Ontario Agricultural College, Guelph, but previous to 1887 little information had been published regarding the work there. The chief means of disseminating information regarding fruit growing were through the reports of the Ontario Fruit Growers' Association, *The Canadian Horticulturist,* and the reports of the Montreal Horticultural Society, and much valuable information regarding the experiences of individual workers reached, and continues to reach, the public in this way.

The need of systematic experimental work in horticulture was keenly felt at that time as the fruit industry was developing very rapidly, and with this development insect pests and fungous diseases were increasing also, and experiments were very necessary to find the most economical way of controlling them. While varieties of fruits had been discussed at fruit growers' meetings for years, no permanent experimental station had been established for the testing of old and new varieties, except at Guelph, and the experience of the individual grower with, of necessity, a limited area for experimental purposes, had mainly to be taken as a rule in the planting of orchards. The origination of new varieties more suitable to the climate of Canada than those which had originated further south was a line of work which a few enthusiastic horticulturists had undertaken with gratifying results, and which offered a field for valuable work at an experimental station. The fine exhibit of Canadian fruit at the Colonial

Exhibition in 1886 had demonstrated the possibility of carrying tender fruit successfully in cold storage across the Atlantic, but further experimental work was necessary. The field for experimental work in different methods of culture for orchards, small fruit plantations, and vegetables, was large. There were many other lines of investigation in horticulture which seemed to demand attention at an experimental station.

The dissemination of definite information to the public regarding fruit growing by reports and bulletins was a necessary outcome of the establishment of an experimental station and experimental work in horticulture

THE HORTICULTURAL DIVISION.

The work of the Horticultural Division has been supervised by three different officers since 1887, viz.: By Mr. W. W. Hilborn, horticulturist from 1886 to 1889; Mr. John Craig, horticulturist from 1890 to 1897; and by the writer from 1898 to the present time.

The original area of land in the Horticultural Division was 40 acres, which has been devoted to experiments with fruits and vegetables. In 1898 the forest belts, comprising about 21 acres, were added to the horticultural department, and in the same year, the writer being appointed Curator of the Arboretum and Botanic Garden, as well as Horticulturist, the Arboretum and Botanic Garden comprising 65 acres of land, was included in the Horticultural Division, making the total area of land over which the horticulturist has had charge since 1898 about 126 acres. At the present time this area is occupied as follows:—

Orchard Enclosure and Vineyard.—Apples, 23¼ acres; plums, 2½ acres; Cherries, 1 1-7 acres; grapes, 2 acres; raspberries, 1 acre; blackberries, ⅓ acre; currants, ½ acre; gooseberries, 1-7 acre; strawberries, ½ acre; vegetables, 5 acres; miscellaneous, 3⅔ acres; total, 40 acres.

Arboretum and Botanic Garden, 65 acres.

Forest Belts, 21 acres.

Total, 126 acres.

EXPERIMENTS WITH LARGE FRUITS, 1887-1906.

APPLES.

Varieties.—One of the most important lines of experimental work of the Horticultural Division during the past nineteen years has been the testing of varieties. The variety is at the basis of successful horticulture, for without the most suitable varieties the grower cannot compete favourably with his fellow fruit growers. Varieties were sought for in many quarters, and when the first plantation was made in the autumn of 1887 and spring of 1888, there had been gathered together 297 named sorts. This number gradually increased, and the named varieties which have been tested up to the present time number 569, as near as has been estimated, and 40 varieties of crab apples.

Among these have been many Russian apples, which it was thought might be hardier than those of American origin.

Conclusions Regarding Named Varieties.—After nineteen years' experiments in testing the named varieties on the market the following conclusions have been reached:

1. The summer and autumn apples have proven to be the hardiest. These include most of the Russian varieties.

2. No winter variety which is equal to such commercial sorts as Greening, King, Baldwin and Northern Spy, has as yet been found hardy enough at Ottawa. Some good winter sorts will, however, live and bear fruit for several years, but most of them will eventually be killed by a severe winter.

3. The chief cause of late-keeping varieties being tender is believed to be that the wood does not ripen thoroughly in the autumn. An early ripening apple means an early ripening tree, and a late keeping apple usually indicates a tree which does not mature its wood early, and in places where the climate is similar to what it is at Ottawa, does not ripen its wood sufficiently to withstand the severe weather.

4. There are some trees, the wood of which ripens early and the fruit is ready for use early in the winter, but keeps all winter. We believe that it is varieties such as these which will give the best satisfaction as winter apples in the colder parts of Ontario and Quebec. The Milwaukee is an apple of this class, and while the quality of this variety is much like Duchess and more suitable for cooking than for eating, we see no reason why other hardy varieties of the best dessert quality which will keep all winter should not be produced from trees originated in Canada.

Some of the Russian apples appear to be hardier than any apples of American origin, and have been the means of extending the culture of this fruit to Southern Manitboa. They are mostly summer and fall varieties, but a few of them will keep well into the winter. Some of the hardiest Russian apples tested in this country, in order of ripening, are: Blushed Calville, Lowland Raspberry, Beautiful Arcade (sweet), Charlamoff, Duchess, Antonovka, Anis, Anisim, Hibernal. Other useful kinds, though not quite so hardy as the above, are Yellow Transparent, Red Astrachan, Alexander.

VARIETIES OF APPLES RECOMMENDED FOR THE PROVINCES OF ONTARIO AND QUEBEC.

The following varieties of apples are recommended for the provinces of Ontario and Quebec: This list is based on the experience at Ottawa during the past nineteen years, and the information obtained by visiting orchards in various parts of the country and by correspondence. This list is substantially the same as that recommended in the Bulletin on Apple Culture, published by the writer:—

Recommended for the Milder Parts of Ontario.

Summer.—Yellow Transparent, Red Astrachan, Duchess.
Autumn.—Gravenstein, Wealthy, Alexander.
Early Winter.—Fameuse, McIntosh, Blenheim, King, Hubbardston, Greening.
Winter.—Baldwin, Northern Spy, Ontario, Stark.

Additional Varieties Suggested for Home Use.

Summer.—Primate, Sweet Bough.
Autumn.—Chenango.
Winter.—Wagener, Swayzie, Tolman.

Recommended for the Colder Parts of Ontario South of Latitude 46°, and for Quebec South of Latitude 46°.

Summer.—Yellow Transparent, Duchess.
Autumn.—Wealthy, Alexander.
Early Winter.—Fameuse, McIntosh, Wolf River.
Winter.—Scott Winter, Milwaukee, North-western (*Greening*), Baxter, Canada Baldwin, La Victoire, and in the more favoured localities, American Golden Russet.

Additional Varieties Suggested for Home Use.

Summer.—Lowland Raspberry, Early Joe, Langford Beauty, Dyer (*Pomme Royale.*)
Autumn.—St. Lawrence.
Winter.—Swayzie, Grimes (*Golden.*)

Hardiest Varieties Recommended for Districts North of Latitude 46°

Summer.—Yellow Transparent, Blushed Calville, Lowland Raspberry, Duchess, Charlamoff.

Autumn and Early Winter.—Anis, Anisim, Antonovka, Patten, Wealthy, Ostrakoff, Hibernal. Peerless and Okabena are promising.

Crab Apples Suitable for all Districts.

Whitney, Martha, Transcendent, Hyslop. Together with the new cross-bred apples recently produced at the Central Farm by the Director, and which are proving hardy in Manitoba, Saskatchewan and Alberta.

There are a number of new varieties growing at the Central Experimental Farm which, though promising, have not been tested long enough to warrant their being recommended.

SEEDLING APPLES.

Believing that desirable varieties of apples are more likely to be obtained from trees originated in Canada or some colder climate, much attention has been paid to the growing of seedlings in the hope of obtaining some better varieties than those already on the market. Persons who have originated seedlings were invited to send specimens of the fruit for examination and if the variety was thought promising, scions were asked for. By this means a collection of 83 varieties of very promising seedlings has been made. In 1890, there were 3,000 seedlings raised from apple seed imported from north of Riga, Russia, planted at Ottawa. These have been gradually reduced, by cutting out the poorer ones and by blight and winter killing, to 75 trees. Out of this number there are a few which may prove superior to some named varieties of the same season, and a large proportion of them is equal to the named Russian apples which have been introduced. Twenty-five of these Russian seedlings have been sent to Manitoba and the Northwest for test there, as they are very hardy.

A new lot of seedlings is beginning to fruit, from which it is hoped that something good will be obtained. A hardy, productive red winter apple of the best dessert quality would be a great acquisition in Eastern Ontario, the province of Quebec and other colder parts of Canada, and in planting these seedlings it was thought the chances were good of obtaining a few superior varieties. Seed was saved of some of the hardiest and best autumn, early winter and winter apples fruiting at the Central Experimental Farm, including St. Lawrence, Wealthy, McIntosh, Shiawassee, Fameuse, Swayzie, Scott Winter, Winter St. Lawrence, Northern Spy, American Golden Russet, Gano, Salome, Edgehill. The first planting of these seedlings was done in 1901 and the number has gradually been increased until there are 1,969 trees now growing. The growing and thorough testing of seedlings takes time and the Horticulturist has been very careful not to recommend a new variety until it has been well tested and thought to be superior in some particular to some other variety of the same season already on the market. Hence the number of seedlings so far recommended has been very few.

Cross-bred Varieties of Apples.

In addition to the work done by Dr. Wm. Saunders, Director, in originating apples for Manitoba and the Northwest provinces by cross-breeding, there has been some work done in this direction by the Horticulturist with a view to obtaining hardier winter varieties for Ontario and the province of Quebec. This work was begun by Mr. John Craig, and continued by the writer, the varieties used by the former being Scott Winter, Walbridge, Northern Spy, and McMahan, and by the writer, McIntosh, Lawver, Northern Spy, North Western (*Greening*), Milwaukee, and Newton. There are at present 217 trees representing these crosses in the Horticultural Department. A few of those which have fruited are promising, but have not been tested sufficiently to recommend.

INDIVIDUALITY IN APPLE TREES.

Records are kept of the yields from each individual tree in the orchard at the Central Experimental Farm, hence it is known what each tree produces. It has been found that there is a marked variation in trees of the same age planted at the same time and growing under very similar conditions. It is now recognized by some of the best authorities that each bud of a tree has individual characteristics which separate it from all other buds, and although the differences in buds are in most cases so slight that it is impossible to detect them, yet in some instances they may be quite marked. Fruit growers have noticed that one tree or bush is more productive than another or bears larger, more highly coloured or better flavoured fruit than other trees of the same variety, but few persons have recorded the yields from different trees, and little definite information has been published on the subject. From the records at the Central Experimental Farm published in the reports for 1903 and 1905, it is shown that some trees have yielded from two to four times as much as others. Scions have been taken from these trees and have been both top grafted and root grafted to learn if this individuality is perpetuated, as it is important to learn if the tendency towards heavy or light bearing is continued when scions are taken from these trees and grafted.

EVAPORATING APPLES.

In 1896 an experiment was tried in evaporating apples, 46 varieties being used in the test. A table was published of the varieties, showing the weight of apples when pared and cored, weight when dried, length of time drying, percentage of water evaporated, weight of dried product per bushel of 50 lbs., and notes were made on the appearance and character of the product.

STORING APPLES.

Notes have been made on the relative keeping qualities of different varieties of apples, but no extensive experiments have been made on account of not having a proper place for storing the fruit.

EXPERIMENTAL SHIPMENTS OF APPLES.

Experimental shipments of apples were made to Great Britain from the experimental farm in 1902, 1903, 1904 and 1905, sometimes with cold storage and sometimes without. The results showed that apples will reach the other side of the Atlantic in good order if properly picked, packed and shipped. Experiments in shipping fruit in cold storage were also superintended by the horticulturist in 1894 and 1895.

CULTURAL EXPERIMENTS WITH APPLES.

It is impossible in a summary report of this kind to mention all the cultural experiments which have been tried, but the following, with the results and conclusions, seem among the most important:—

Fall versus Spring Planting.—An experiment was tried in the autumn of 1887 for the purpose of comparing fall with spring planting of trees at Ottawa. The results were unfavourable to fall planting, and experience during later years confirms this. There appears to be three chief disadvantages of planting in the fall at Ottawa or where the climate is similar. Trees planted in the autumn are not sufficiently charged with moisture to withstand the winter and are killed by drying out. Trees planted in the autumn are more liable to sunscald the following spring than those which are planted in the spring and have had a season's growth. Trees planted in the autumn are more likely to heave during the winter than if planted in the spring.

Root-killing of apple trees.—The root-killing of apple trees is a serious drawback to growing apples in a severe climate. When there is a good covering of snow the roots are sufficiently protected, but if the ground is bare in winter the roots are liable to be killed. There are two preventives of root-killing, namely, propagating trees on hardy roots, and protecting the trees in winter by a mulch, which is obtained in the best form by means of a cover crop. Many trees which are bought have been propagated on stocks which have not been selected with a view to hardiness, and hence may be too tender for some districts. At the Central Experimenal Farm trees have for the past ten years been propagated on seedlings of some of the hardier crabs or on *Pyrus baccata,* and these have so far given good satisfaction.

Cover Crops.—In the winter of 1895-6 root-killing of fruit trees was very widespread in the provinces of Ontario and Quebec, owing to the scarcity of snow and to alternate thawing and freezing, and since that time cover crops have received much attention in the horticultural department, and experiments have been conducted every year since with the object of finding a plant or combination of plants that would give the desired winter protection, add a fair amount of humus to the soil and be easy to handle in the orchard in the spring. Crimson clover, Mammoth Red clover, Common Red clover, Alfalfa, Soy beans, Cow Peas, English Horse beans, Hairy Vetch, Summer Vetch, Buckwheat and Rape, have all been tried for this purpose.

Crimson clover has been found too uncertain in this district, the plant not making sufficient growth before winter. In some districts it does well.

Mammoth Red clover and Common Red clover sown about the middle of July and earlier at the rate of about 12 pounds to the acre, make good cover crops, the Mammoth Red giving a little the better results.

Alfalfa is not as satisfactory as Mammoth Red clover, being more exhaustive of soil moisture and more difficult to handle in the spring.

Soy beans sown in drills 28 inches apart at the rate of 37½ pounds per acre on June 18, made a good growth, but are killed by the first frost, and are hence not satisfactory.

Cow Peas are too tender.

English Horse beans, sown in drills 28 inches apart at the rate of one bushel per acre have done well and continue growing till severe frosts. They hold the snow well in winter, as they do not break down easily. They are rolled in the spring and work into the ground easily. Rape, sown broadcast among the Horse beans, makes a good bottom cover.

Hairy Vetch, is a good cover crop, making strong growth late in the season. It may be sown broadcast or in drills. It is somewhat difficult to plough under in the spring.

Summer Vetch or Tares.—The Summer Vetch is much cheaper than the Hairy Vetch, and is a rapid grower. It kills out in the winter, but furnishes a good cover.

Buckwheat is not a good cover crop, as it adds no plant food to the soil, and the leaves are killed by the first frost, but it is better than nothing and sometimes proves useful for late food for bees, at the same time helping to hold the snow.

Rape grows rapidly in the autumn and makes a good ground cover. It does not add any plant food to the soil, but it is easy to plough under in the spring, as it is killed by winter. Of the non-leguminous plants, or those which do not add nitrogen to the soil, it is one of the best.

Cover Crops and Conservation of Moisture.—As some plants exhaust the soil more rapidly of soil moisture than others, experiments have been conducted in the orchard with cover crops and chemical analyses have been made by the Chemist, Mr. Frank T. Shutt, to determine the percentage of moisture in the soil under different cover crops at different dates, the results of which have appeared from time to time in the Chemist's report.

Cover Crops and Plant Food.—In addition to their use in holding snow in winter and protecting the roots of trees, cover crops have a value in that they furnish vege-

table matter to plough under in the spring for the purpose of obtaining humus, and, in the case of leguminous plants, nitrogen. In the autumn they act as catch crops, preventing plant food from leaching. Experiments have been conducted to determine the yields from the various cover crops, and analyses have been made of the same. The former have been reported on by the Horticulturist, and the latter by the Chemist.

Mulching the Soil with Green Clover.—From 1898 to 1902 the system of cover crops was changed in part of the orchard. Seed for the cover crop was sown in May and the clover was allowed to grow during that season and to remain and protect the ground the following winter. The second season, instead of ploughing under the clover in the spring, it was allowed to grow and was cut at intervals during the summer and was not ploughed up until the next spring. By cutting the clover when the flower heads were just beginning to show, when it was from 18 to 20 inches in height, it was found that from four to five good cuttings could be made, and by weighing some of the material at each cutting it was found that about 25 tons of green clover was cut during the season. The clover from each cutting was left to rot on the soil and acted as a partial mulch. The trees did well under this treatment, but this system had to be discontinued for a time on account of the increase of couch grass in the land. When an orchard soil is wet or so moist that drought is not feared this method will give good satisfaction, but we do not advise it for most situations, as conservation of moisture is usually a most important consideration, and this can be brought about best by thorough cultivation.

Conclusions Reached Regarding Cover Crops.—Cover crops are valuable for protecting the roots of trees in winter, holding the snow, adding humus and plant food to the soil when ploughed under, and acting as a catch crop in autumn to prevent leaching of available plant food. In western Ontario, soil should be kept thoroughly cultivated from early in the spring until about the middle of July. In eastern Ontario and the province of Quebec cultivation may cease as early as July 1, as thorough ripening of the wood is more important than conservation of moisture. The cover crop should be turned under in the spring and cultivation begun as early as possible.

Top Grafting Apples.—It has been known for many years that trees having poor trunks are much more satisfactory when top grafted on hardy trunks and will bear sooner, and it was generally supposed that trees top grafted on hardy stocks would be decidedly hardier in the wood than when grown in the ordinary way. As none of the best winter apples had been found hardy enough at Ottawa when grown as standard trees it was decided to try top grafting. From 1898 to 1903 ninety varieties of apples were top grafted. After top grafting, some of the varieties which had been too tender gave promise of succeeding, but the severe winter of 1903-4 killed practically all those which had proven tender when tried as standard trees. A Northern Spy which had been top grafted on Duchess for thirteen years was killed completely back to the stock which was as healthy as ever. From this experience with top grafting tender varieties on hardy stocks it seems conclusive that top grafting will not make a variety sufficiently hardy to withstand the winter where the climate is similar to that at Ottawa, if it is tender when grown as a standard. Top grafting will, however, bring a tree into bearing sooner and will permit of growing varieties which sun-scald on the trunk or are weak in the trunk in other respects.

Sun-scald.—There is much injury to apple trees from sun-scald in the northern and eastern parts of Ontario and the province of Quebec, and many a grower has been discouraged on account of the injury to his trees by it, trees frequently being killed outright by it. Newly planted trees are, as a rule, more seriously affected by it than older ones, but both often suffer badly. The unhealthy appearance of the bark on the south and southwest sides of the trunk of the tree and on the larger branches is the first indication of this injury. Afterwards the bark dries up and falls away. The injury occurs during the latter part of winter or very early in the spring when there are warm days and cold nights. It has been found at the Experimental Farm

that this can be prevented to a very large extent. One of the best means of prevention is a wooden veneer which encircles the trunk, thus preventing the rays of the sun from striking the trunk. It is better loose so that there will be an air space between it and the tree. Building paper, corn stalks, boards, sacking or almost anything else which will shade the trunk may be used. Black substances, such as tar paper, should be avoided. The protection should be given in autumn. Nothing, however, that will be likely to harbour mice should be used.

Mice.—Some winters great injury to apple trees is done by mice, hundreds of trees having in some places been girdled and destroyed. When a young orchard is just coming into bearing the disappointment is very great when after the snow disappears in the spring the trees are found girdled and the prospective returns from the orchard are destroyed. The following recommendations are made after nineteen years' experience: All rubbish which will harbour mice should be removed from or near the orchard in autumn. The trunks of trees should be wrapped with building paper in autumn. After wrapping thousands of trees in this way with practically no injury from mice this method is confidently recommended as the simplest and best. Tar paper is also satisfactory, but injury to trees has occurred in places where tar paper has been used, and it is not recommended. The wooden veneer used for preventing sunscald is also an excellent means of preventing the depredations of mice. Banking up the earth about the base of the tree to the height of about one foot is also a fairly good plan, and even tramping the snow about the base of the trees will answer a similar purpose. If a tree is girdled by mice it usually dies the same year or the year following. If the girdle is narrow the tree may be saved by bandaging to prevent the wood from drying out, and this method may be adopted when the tree is only partly girdled. When a tree has been injured by mice it has been found a good practice to cut or scrape away the injured part and cover the wound with grafting wax or paint. Girdled trees may also be saved by bridge grafting or connecting the bark above and below the girdle with scions.

Close Planting of Apple Trees.—In the spring of 1896 there were 144 Wealthy trees set out 10 by 10 feet apart, or at the rate of 435 trees to the acre. The expenses and receipts from this orchard have been kept and published from time to time in the annual reports. In the report for 1905, when the last statement was published, it was shown that the average net profit per acre per year from 1896 to 1905 was at the rate of $59.03, and the average net profit per acre from 1899 to 1905, or since the trees began to fruit, was at the rate of $105.75. There is a good crop of fruit in 1906, and the average profit will probably be increased. This method of planting apple trees is only suitable to a few varieties which begin to bear early, and is not recommended for general practice, but the experiment is interesting and suggestive. The trees have so far been kept in bounds by pruning, but eventually some of the trees will be removed.

Each year we are more convinced that apple trees will not be long lived in the colder parts of Ontario and Quebec, and that the most profitable method of planting will be that by which one will get the largest returns from his land in the shortest time.

PLUMS.

Varieties.—During the past nineteen years 253 named varieties of plums have been tested at the Central Experimental Farm, including most of the European, Japanese, Americana, Nigra, Miner and Hybrid varieties. Briefly stated, it may be said that none of the European and Japanese plums have proven satisfactory, being either too tender in fruit bud or wood, or both. Some of the European varieties are a little hardier in the fruit bud than others, among which are some of the Russian importations and some seedlings originated on the Island of Montreal. The winter

killing of the fruit buds appears to be due more to dryness of atmosphere with cold weather than low temperatures, merely, the European varieties which will not fruit at Ottawa being grown very successfully along the lower St. Lawrence where the river is open during the winter. The Miner plums are also too tender in the fruit bud at Ottawa. Some of the hybrids between Japaneses and Americana varieties are promising, but for eastern and north central Ontario and the great part of the province of Quebec, the main reliance must be on the Americana and Nigra varieties.

Americana and Nigra plums.—The Americana and Nigra plums are improved forms of the wild species of the northern parts of the United States and of Canada. It is only about 50 years since the Americana plums were thought worthy of cultivation and improvement, and it is only during quite recent years that many varieties have been propagated and named. The size, appearance and quality have already been much improved and the possibility for future improvement is great. The appearance of the plums is all that could be desired, and the best varieties are almost large enough but there is great room for improvement in the character of the skin and the flavour of the fruit, although the latter is good. The skin of the Nigra plums, derived from the Canadian species, is thinner than that of the Americana and breaks up easier when cooked.

VARIETIES OF PLUMS RECOMMENDED FOR THE PROVINCES OF ONTARIO AND QUEBEC.

While the experience at Ottawa would not be a guide as to the varieties of plums most suited to the warmer parts of Ontario, the writer has had a good opportunity to learn by correspondence and by visiting the orchards of plum growers which are the best kinds to plant. The following list is very similar to that published in Bulletin No. 43, on Plum Culture, by the writer.

Americana and Nigra.—Aitkin, Bixby, Mankato, Cheney, Wolf, Hawkeye, Stoddard. Other promising kinds are Admiral Schley, Bomberger, Smith, Lottie, U.S., Terry, Atkins, Bouncer.

European.—Bradshaw, Imperial Gage, Gueii, Shippers' Pride, Lombard, Quackenboss, Yellow Egg, Grand Duke, Golden Drop, Bavay (*Reine Claude*). The Shropshire Damson is one of the best of the Damsons.

Japanese.—Red June, Abundance, Burbank, Chabot. The Satsuma is a red-fleshed variety desirable for canning.

Hardiest varieties of European plums.—Early Red (Russian), Mount Royal, Raynes, Richland, Glass, Montmorency, Perdrigon, Ungarish.

Canning and Preserving Plums.—As the Americana and Nigra plums vary much in quality, experiments have been conducted to determine which kinds were best when preserved. The result of these tests were published in the bulletin on Plum Culture in which are also given recipes.

Sand Cherry as a Stock for Plums.—Experiments have been conducted with different stocks for grafting plums. The most interesting stock has proven to be the sand cherry. Trees of Americana plums grafted 13 years ago are still in good condition and bearing well. The trees are considerably dwarfed by this stock. The sand cherry may prove useful where close planting is adopted, as many more trees could be planted on an acre when dwarfed by this stock. Trees grafted on this stock are not, however, as firm in the ground as they might be, as the Sand Cherry has not many root fibres. This may be a disadvantage as the trees get older, as winds may loosen them too much.

PEARS.

Pears have not proven a success at Ottawa. Most of the named varieties on the market in this country have been tested, but none of the better kinds have survived. The Flemish (*Beauty*) has proved the hardiest good pear, but the tree blights and it does not live long at Ottawa. At Oka, further down the Ottawa, it has done well, and also succeeds fairly well at Montreal. Some of the Russian varieties are very hardy, but are inferior in quality and very subject to blight. Seedling pears are being grown in the hope of getting some hardier sorts.

The following list of pears, recommended in Bulletin No. 147, of the Ontario Department of Agriculture, by the Board of Control of the Ontario Fruit Experiment Stations, of which the writer is a member, is given as the best list for Ontario where pears succeed. It is only in the mildest parts of the province of Quebec where pears are profitably grown, and Flemish is the most desirable variety to plant.

VARIETIES OF PEARS RECOMMENDED FOR THE PROVINCE OF ONTARIO.

Commercial.—Giffard, Clapp, Bartlett, Boussock, Flemish, Howell, Louise, Duchess, Bosc, Clairgeau, Anjou, Kieffer.

Domestic.—Summer Doyenne, Giffard, Bartlett, Flemish, Sheldon, Seckel, Bosc, Anjou, Lawrence, Josephine, Winter Nelis.

PEACHES.

Peaches and apricots have both been tested at the Experimental Farm, but neither have been found hardy enough. The peach being tender both in wood and fruit bud, and the apricot in fruit bud, and to some extent in the wood. The so-called Russian apricots were not found to be sufficiently hardy. Seedling peaches produced at the northern limit of the production of this fruit are being tested.

Peach culture in Ontario was looked into very thoroughly by Mr. John Craig when horticulturist, and a bulletin was published on this subject in 1898. The list of varieties recommended in that bulletin needs to be changed somewhat as newer kinds have been more thoroughly tested since that time. The following is the list recommended and published by the Board of Control of the Ontario Fruit Experiment Stations, which the writer considers the best list for Ontario:—

Commercial.—Sneed, Alexander, Hynes, St. John, Mountain Rose, Early Crawford, Champion, Brigdon, Fitzgerald, Reeves, Elberta, Oldmixon, Stevens, Smock.

Domestic.—Hynes, St. John, Early Crawford, Oldmixon, Longhurst, Stevens.

CHERRIES.

Cherries have been thoroughly tested at Ottawa and after nineteen years' experience no cultivated variety of cherry has been found which is profitable to grow at Ottawa. The Morello cherries are the hardiest, but as a rule the fruit buds of these are winter killed. The same fact is observed with cherries as with European plums, namely, that when the air is comparatively moist even if the temperature is low, cherries will succeed better than they do where the air is dry and cold. Thus, cherries succeed much better along the lower St. Lawrence than they do at Ottawa.

Among cherries introduced from Russia are some of the hardiest kinds. Orel 25, Vladimir, Minnesota Ostheim, and Cerise d'Ostheim are the four hardiest.

In 1890 the Ontario Fruit Growers' Association received a number of seedling cherry trees from Russia under the name of Koslov Morello. Twenty-one of these were sent to the Central Experimental Farm for test. They were slow in coming into bear-

ing and eight years after planting averaged only 5 feet 6 inches in height. Most of these trees produced fruit of inferior quality, some being bitter, and others very acid. Two, however, were quite promising and have been propagated, but are very slow in growing. These low growing cherries may prove very useful in the north as they are protected to some extent with snow. When there is little snow the fruit buds are killed as is the case with other cherries.

VARIETIES OF MORELLO CHERRIES RECOMMENDED FOR THE PROVINCES OF ONTARIO AND QUEBEC.

For the colder parts of Ontario and for Quebec: Orel 25, Vladimir, Minnesota Ostheim, Cerise d'Ostheim.

For Ontario except the colder parts: Orel 25, Orel 24, Early Richmond, Montmorency, English Morello.

PROPAGATING CHERRIES ON HARDY STOCK.

It was soon found that the Mazzard and Mahaleb stocks used in the trade for cherries are too tender for the Ottawa district as many trees were root-killed, hence hardier stocks were tried, the Bird or Pin Cherry—*Prunus pennsylvanica*—being used for this purpose. Experiments with Bird Cherry were begun in 1892 and have been continued since. It has been found that the cultivated cherries will make a good union with Bird Cherry. Better results are obtained from budding than from grafting, and crown grafting has given better results than root grafting. The Bird Cherry starts growth very early in the spring and if grafted the work must be done early. The Bird Cherry may not be a desirable stock in commercial work as not as large a percentage of buds or grafts take as on Mazzard or Mahaleb stock, but where hardy roots are desired it is a good stock to use.

Sand Cherry has also been tried as a stock for the cultivated cherry, but the union proved poor and it is of no value for this purpose.

Whitewashing Cherry Trees to Protect Fruit Buds.

As the fruit buds of cherries were so frequently destroyed, an experiment was tried in April, 1899, by whitewashing the trees to retard the swelling of the buds, as it had been found by other experimenters that whitewash would retard the swelling of peach buds and prevent injury to the bud by spring frosts. There was a decided retardation of the buds due to the whitewash, but there was no blossom on either sprayed or unsprayed trees, showing that the injury to the buds was done before they were sprayed and before they started to swell, as the buds were still dormant when sprayed.

GRAPES.

Grapes are grown with good success at Ottawa, although all the varieties which ripen in the best grape districts do not mature here. There are 260 named varieties growing in the vineyard at the Central Experimental Farm, and the largest number of kinds which have ripened in any one year is 130. In the most unfavourable seasons about 30 varieties ripen, and if growers in districts where the climate is similar to that at Ottawa would limit themselves to the earliest kinds they could have ripe grapes every year. A number of seedlings originated at the Central Experimental Farm are fruiting and a few of them are promising.

The following named varieties of grapes are recommended for the provinces of Ontario and Quebec:

For Best Grape Districts of Ontario.

Black.—Moore, Campbell, Worden, Wilder, Concord.
Red.—Delaware, Lindley, Agawam, Vergennes, Catawba.
White.—Niagara, Diamond.

For more Northerly Districts with Low Elevations where Climate is much like that at Ottawa.

Black.—Champion, Manito, Early Daisy, Moore, Campbell, Worden, Wilder.
Red.—Moyer, Brighton, Delaware, Lindley.
White.—Golden Drop, Winchell, Diamond.

For Districts where only the Earliest Kinds will Ripen.

Black.—Champion, Manito, Early Daisy, Moore, Campbell.
Red.—Moyer.
White.—Golden Drop.

EXPERIMENTS IN GRAPE CULTURE AT OTTAWA.

System of Training.—Most of the vines in the vineyard at the Experimental Farm are planted in rows 10 feet apart, with the vines 10 feet apart in the rows. In part of the vineyard 148 vines were planted in rows 4 feet apart, with the vines 3 feet apart in the rows. These vines were trained according to the Post or French method, stakes being driven down and the vines tied to them. After a thorough test it may be said that this method is quite unsuited to a climate where it is important for the grapes to get as much light and sunshine as possible, as the foliage is very dense when the vine is confined to a single post. It was found that the grapes ripened about a week later and not so thoroughly when grown by this system than by the more open methods.

Some vines were planted with a view to forming an arbour, but it was soon found that the need of winter protection rendered this system unsatisfactory. The Fan and Horizontal methods have also been tried, but it was found for a climate such as there is at Ottawa where the vines have to be covered with soil every winter a method had to be adopted which would reduce the labour of covering to a minimum. It was found that when trained by the Horizontal Arm system the arms, which are permanent, get stiff and are difficult to bend down and cover with soil. A better method was found in a modification of the High Renewal system, the only important difference being that instead of renewing every year, the arms are left on for at least two years to insure having ripe wood and reduce the danger from winter killing. The two arms may be renewed in alternate years if considered necessary. By this method the arms, which start from a head near the ground, are always supple and easily bent down and covered with soil. In the report for 1901 the method adopted at the Central Experimental Farm is more fully described. In the report for 1896 full particulars are given of the planting and care of vineyards and the methods of training the vines for the best grape districts.

Protecting Vines During Winter and Spring.—It has been found that in order to insure the vines coming through the winter in good condition it is necessary to bend them down and cover them lightly, soil being found to be the best material for this purpose. This covering has not so much value as a means of protecting the vines from low temperatues as in protecting them from sudden changes of temperature. This was well shown this year when there was little snow and the vines thus much more exposed than usual to low temperatures, and when the vines came through in fine condition.

The soil should be left on the vines as late in the spring as possible without injury to the swelling buds, as a few degrees of frost after the vines have been uncovered are sufficient to destroy the crop for that season. At Ottawa the vines are not uncovered until the second week of May.

Experiments to Preserve Grape Juice.—From 1893 to 1896 and 1897 experiments were conducted with different formulas for the preservation of grape juice. Twenty-three different methods were tried. The conclusions reached were as follows:—

'It would appear from the foregoing (experiments) that the natural flavour of the grape juice may be preserved intact by raising the temperature of the juice gradually to 170 degrees Fahr., keeping it at this point for ten minutes, and then quickly bottling it, taking care to use absolutely air-tight and thoroughly sterilized vessels. These vessels should be taken from a tank or kettle of boiling water, immediately filled and corked or covered, with the least possible delay. The addition of sugar in the proportion of four ounces to each quart of liquid will improve the quality and palatability of the juices of the more acid varieties, such as Clinton, Bacchus and Marion.'

The following deductions were also drawn:—

1. Formalin, while a proved ferment arrester, imparts such a disagreeable flavour to the juice that it cannot be used, at least as strong as in the proportion of ¼ per cent.

2. Sugar added to the grape juice with formalin masked the flavour of the latter somewhat, but did not obliterate it entirely.

3. Salicyclic acid, 175 grammes with 2 ounces of sugar to each pint, produced the most palatable beverage (but the use of antiseptics is not recommended nor encouraged).

4. Samples were successfully preserved when heated for 10 minutes at 160° F. with sugar at the rate of 2 ounces to each pint of juice. Duplicate samples without sugar were also successfully preserved, but were not generally as palatable as the former.

5. 160° F. seems to be the lowest temperature that may be used in the preservation of grape juice. The juice may be held at this temperature for 15 or 20 minutes without imparting to it any unpleasant boiled flavour.'

RASPBERRIES.

There have been 103 named varieties of raspberries tested at the Central Experimental Farm, including red, white, purple and black. Some of the red varieties give very satisfactory results. The white varieties are a little too tender; the purple and black caps are very uncertain, being also not so hardy as the red. As information has been obtained from various sources regarding the varieties which succeed best in other parts of the provinces of Ontario and Quebec, a list is also published for the districts where the climate is warmer than it is at Ottawa.

VARIETIES OF RASPBERRIES RECOMMENDED FOR ONTARIO AND QUEBEC.

For the milder parts of Ontario—
Black.—Hilborn, Older, Gregg, Smith Giant.
Purple.—Columbian, Shaffer.
Red.—Marlboro, Herbert, Cuthbert.
White.—Golden Queen.

For the Colder Parts of Ontario and Quebec—
Black.—Hilborn, Older.
Purple.—Columbian, Shaffer.
Red.—Marlboro, Herbert.
White.—Golden Queen.

SEEDLING AND CROSS-BRED VARIETIES OF RASPBERRIES.

When Dr. Wm. Saunders, the Director of the Dominion Experimental Farms, came to Ottawa he brought with him from London, Ont., about 200 unnamed seedling and hybrid raspberries. As reliable information regarding these was obtained the less promising ones were discarded, the number now having been reduced to twenty-two. Of these the best are Sarah, Brighton, Count and Sir John. All of these are very hardy. The Sarah is of very fine quality, and the last three very productive.

LAYING DOWN RASPBERRIES FOR WINTER PROTECTION.

An experiment was tried in 1894, 1895 and 1896 to determine if it were profitable to bend down the canes of raspberries and cover the tips with soil for better protection in winter. This experiment showed that the canes bent down were less injured by winter and that it paid to protect the canes in this way, at Ottawa, the protected plants out yielding the unprotected in almost every case.

SUMMER PRUNING.

An experiment was tried in 1894, 1895 and 1896 to determine if better results would be obtained by pinching off the tips of the raspberry canes in summer when 15 to 20 inches in height than by leaving them grow to their full height. Other plants were left unpruned. The unpruned plants yielded best.

BLACKBERRIES.

Most of the varieties of blackberries which are offered for sale have been tested at Ottawa, but few of them are sufficiently hardy to produce much fruit. The two hardiest varieties tested are Agawam and Snyder. Eldorado is also a fairly hardy variety. For south-western Ontario the Kittatinny is one of the best sorts to plant.

CURRANTS.

From experience with 110 varieties of currants at the experimental farm, the following are recommended for general planting:—

Black.—Saunders, Victoria.
Red.—Wilder, Pomona, Victoria, Cherry, Fay.
White.—White Grape.

The Wilder, Cherry and Fay, although the largest currants, are rather tender in fruit bud, but the Wilder is the hardiest.

SEEDLING VARIETIES.

When Dr. Wm. Saunders removed to Ottawa from London, Ont., in 1887 he brought to the experimental farm about 150 promising seedling currants, most of which were black varieties. These have been gradually reduced in number, the best 29 now remaining. Of these the most promising black varieties are: Saunders, which is now sold by the nurserymen; Ogden, Kerry, Ontario, Eclipse, Magnus, Ethel, Climax, Success, Clipper, Winona and Topsy. Descriptions of these were published in the annual report for 1905.

GOOSEBERRIES.

Gooseberries have been given a thorough test, and 97 named varieties have been tested, including many of the English sorts. It has been found that the latter are quite unsuitable for general culture, owing to their being so badly affected by mildew, which has not yet been satisfactorily controlled by spraying. Those which have proved freest from mildew are Riccardo, Alcock's King, Yellow Criterion, Glenton Green, Triumph, Snowball, Antagonist and Queen of Trumps. In some parts of Canada Whitesmith and Industry have proved comparatively free of mildew, but these have not been among the least affected at Ottawa. The best success with English gooseberries is obtained in gardens and in clay soil.

Of gooseberries originated in America, the following have given the best results and are recommended:—

Varieties of gooseberries recommended for general planting.—Pearl, Downing, Red Jacket.

STRAWBERRIES.

The named varieties of strawberries have been very thoroughly tested at Ottawa, and since 1887 there have been 513 kinds under trial. There are so many new varieties of strawberries introduced each year that the list of those recommended has to be changed from time to time as those of superior merit are found.

The following are those which are recommended at the present time:—

Commercial.—Splendid (perfect), Beder Wood (perfect), Warfield (imperfect)—not suited to light soil, Williams (perfect), Greenville (imperfect), Sample (imperfect) Buster (imperfect). Pocomoke and Parsons Beauty are also very good commercial berries.

Domestic.—Excelsior (perfect), Splendid (perfect), Senator Dunlap (perfect), Lovett (perfect), Bubach (imperfect), Wm. Belt (perfect).

SEEDLING STRAWBERRIES.

Considerable work has been done in testing seedling strawberries, but as yet no variety has been produced which was thought worthy of introduction. Of 650 seedlings which fruited in 1889, 40 were saved. These have been gradually reduced in number and of this lot only 6 are still being tested. Most of these are of very good quality, but lack other characteristics desirable in a commercial berry. In 1897 about 1,400 seedlings were raised from some of the best named varieties. These were gradually reduced to 34, among which were some of great promise. Last winter these were practically all winter killed. Another lot of seedlings has been raised and set out, in the hope of better success.

CULTURAL EXPERIMENTS WITH STRAWBERRIES.

Experiments have been conducted with strawberries in various methods of planting and in different systems of culture. It has been found that the matted row system is more suited to the climatic conditions of Eastern Canada than the hill system, although by mulching good results may be obtained by growing them in the latter way. The hill system may be adopted where strawberries are grown for home use if the plants are properly looked after, as the fruit is larger when grown in this way. Two bulletins on the strawberry—No. 5, and No. 27—have been published, but owing to the demand for information regarding the strawberry both of these are now out of print.

BLOSSOMING RECORDS OF FRUIT.

The various causes of unfruitfulness in trees has been discussed for many years, but it is only during recent years that much attention has been given to the relation of the blossoming season of different varieties of fruits to the setting of the fruit. It had been observed that where varieties were intermingled in an orchard there was generally a better crop than where certain varieties were grown by themselves. In order to learn the varieties of fruit which blossomed at the same time, so as to furnish information to intending planters, the following circular was sent to a number of the leading fruit growers of Canada in 1895:—

'Dear Sirs—The cause of the unfruitfulness of some varieties of large and small fruits when planted in large blocks by themselves is now understood to be due to self-

sterility, complete or partial, causing imperfect pollination and fertilization. The remedy is the intermingling of varieties in the orchard for the purpose of securng cross-fertilization. To obtain the best results the varieties adjacent to each other should blossom at, or about the same time.

Accurate information with regard to the time of blossoming of the different varieties of fruits is much needed. Will you assist in securing data on this important subject?'

Small pass books, ruled and headed, were sent to each person.

These records were made for five consecutive years, and are still being made at the Experimental Farm. The average result for apples was published in Bulletin No. 37, and for American plums in Bulletin 43. The value of these records can be appreciated when it is stated that experiments elsewhere covering five years work have shown that with one exception the American plums were all found to be self-sterile. The blossoming records, showing that varieties bloom at different times, together with the fact that some varieties are self-sterile, show the importance of planting near each other those kinds which bloom at the same time, in order that maximum crops may be produced.

VEGETABLES.

Vegetables have received much attention in the Horticultural Division from the time the work was organized, in 1887, to the present time. Hundreds of varieties offered for sale by seedsmen have been tested during the past nineteen years, with the result that it has been possible to recommend concise lists of best vegetables for farmers. The last list was published in the report for 1905, and as there are practically no changes to make this year it need not be repeated here. Varieties of vegetables are still tested, but for the most part these consist of the few sorts recommended in the list of best varieties, with any new ones which are offered for sale.

Following are some of the principal facts recorded regarding different vegetables:

Beans.—Notes have been taken on the time when different varieties were ready for use; the quality of the beans, and productiveness.

Beets.—Notes have been made on the relative earliness, shape, and colour of flesh of the different varieties.

Cabbage.—The time when each variety was ready for use, the weight of average heads, the proportion of plants which headed, the relative freedom from disease are the principal records which have been made.

Cauliflower.—The cauliflower has received considerable attention. After a thorough test of most of the varieties offered for sale it was found that more satisfactory results were obtained from successive sowings of the Extra Early Dwarf Erfurt than from later varieties. The root maggot is very troublesome in the early part of the season and often causes the almost total destruction of early cauliflower plants. Two good methods of protecting the plants have been found. First, by means of small, tar paper discs which, when carefully put on, lie close to the ground and prevent the insect from laying her eggs, or prevent them from hatching. Good results have been obtained by this method, but the disc must be put on well and closely encircle the stem. A surer method, and one which may be used by amateurs, both in growing cauliflower and other crops, is to grow the plants inside a cheesecloth enclosure. Very good results have been obtained when cauliflowers were grown in this way.

Carrots.—Notes have been taken on the time when ready for use, and the shape and general appearance of the variety.

Celery.—Experiments have been tried in growing celery in beds versus rows; and in hotbeds versus cold frames. While celery may be grown successfully and

blanched by these special methods, the most economical method under most circumstances is growing the celery in rows. The keeping properties of the different varieties have been tested, also the quality of the same.

Corn.—The date when ready for use, size of ear, quality, and productiveness have been the principal notes taken.

Cucumbers.—Notes have been taken on dates when ready for use, length of time the cucumbers will remain green, yield, and general appearance.

Lettuce.—Different varieties have been tried for forcing in hotbeds, but special attention has been paid to field culture and notes taken on the time when ready for use, length of time which the different varieties remained in use, tenderness, and general characteristics of the variety.

Melons.—Experiments have been tried both in growing melons by planting seed in the open ground and not using glass; by growing the plants in hotbeds and transplanting to the open field, after which no glass was used; by using small frames with glass, and by using ordinary hotbed sash. While some seasons melons will ripen at Ottawa if grown in the open air without glass, it is so late that they are not in great demand. Other years they will not ripen at all. The most satisfactory method is to sow the seed or plant young plants in the open in hills with hot manure beneath and keep the plants under glass until July.

Pease.—Notes have been made on the time of being ready for use of the different varieties, the height of the plants, the length of pods, quality of the peas, and productiveness of the different varieties.

Potatoes.—Experiments with potatoes have been numerous, and the results of these were summed up in Bulletin No. 49 on Potato Culture, by the writer, published in 1905.

Radishes.—The time of being ready for use, length of time remaining in use, quality and general appearance of the different kinds have been recorded.

Tomatoes.—The tomato has received much attention owing to its importance and popularity. Notes on the time of maturing, appearance and productiveness have been made. Experiments have been tried in pruning, and it has been found that the most satisfactory method of pruning yet found is pinching out the terminal buds when the young plants have about six leaves, giving the plants more room so that the axillary shoots will develop, and pinching again about a month after setting in the field.

All the other common vegetables have been tested and notes taken on the characteristics of the different varieties.

EXPERIMENTS IN GROWING VEGETABLES IN A CHEESECLOTH ENCLOSURE.

For four seasons experiments have been tried to learn with what success vegetables could be grown in an inclosure made of cheesecloth, the top, sides and ends of the framework being completely covered with cheesecloth. It has been found that lettuce, radish, beans and cauliflower succeed best inside the enclosure and are earlier and more tender than outside.

The enclosure prevents cauliflowers and radishes from being injured by the root maggot. The cheesecloth enclosure should be of use in cities and towns where it is difficult to have a garden owing to the injury done by cats, dogs and even young children. Vegetables are tenderer, as a rule, than those grown outside. Where the root maggot is bad the enclosure may be used profitably for growing early cauliflowers.

SELECTION OF PEAS, BEANS AND TOMATOES.

During the past seven years an experiment has been in progress in selecting garden peas with the object of developing, if possible, earlier and more productive strains. The results are very encouraging and the effect of selection in regard to increase in yield and earliness is quite marked in some cases. A similar experiment has been carried on with beans for six years, and with tomatoes for three years, with good results. The quantity of seed from these selections has not been increased much yet, as the object is to carry on as rigid a selection as possible for several years longer, and this is best done from single plants. The value of selected seed was especially marked in tomatoes in 1905, when the Sparks Earliana from seed selected from the earliest fruit in 1904 yielded more than two and one-half times as much ripe fruit before August 10, as plants grown from imported seed.

The importance of using homegrown seed if properly ripened, selected and stored, has been well shown in these selections of peas, beans, and tomatoes.

TOBACCO.

Tobacco has been grown in the Horticultural Division since 1893, and most of the varieties offered for sale by American seed houses have been tested. Notes have been taken on the time of maturing of the different kinds, as it is important to know those which mature early. Experiments have been conducted in 'topping' and 'priming' and comparisons made between transplanted and not transplanted plants. Tobacco has also been sent to experts for manufacturing, and the results of these tests have been published in the Annual Reports.

FUNGOUS DISEASES.

The fungous diseases relating to fruits and vegetables are dealt with by the Horticulturist. Many specimens of affected fruits or fruit trees are sent in each year for identification and for recommendations for treatment, and as far as possible reliable information has been given. Descriptions of many of the fungous diseases affecting fruits and vegetables have been published in the report of the Horticulturist and in bulletins.

SPRAYING.

The spraying of fruits and vegetables to prevent the ravages of insect pests and fungous diseases has been one of the strong features of the work of the Horticultural Division and from 1890 to the present time every annual report except one contains the results of some experimental work in spraying. The principal experiments are herewith summarized:—

1890, experiments with copper carbonate, copper sulphate, and hypo-sulphite of soda to prevent Apple Spot. The same year 14 combinations of fungicides were tried to learn what strength could be used without injury to foliage.

1891, experiments to determine the relative efficacy of copper carbonate in suspension and solution, and an unwashed solution, and the possibility and effect of using Paris green with these mixtures.

1892, comparing the efficacy and cost of ammoniacal copper carbonate and dilute Bordeaux mixture. Experiments, to prevent Grape Mildew and Anthracnose. Experiments to prevent Gooseberry Mildew, also to prevent the Spot or Blight on the native plum.

1893, experiments with Bordeaux mixture and ammoniacal copper carbonate to prevent Apple Spot. Experiments to try the effect of dilute sulphuric acid on foliage.

1894, experiments were conducted at seven places in Ontario for the prevention of Apple Spot.

1895, practical demonstrations in spraying were given in the province of Quebec, and experiments against Apple Spot were conducted at two places in Ontario under the direction of the Horticulturist. Experiments were conducted to determine the effect of Lysol in preventing Peach Curl.

1896, experiments with various combinations of leading fungicides and insecticides with a view to preventing the cracking of pears, Apple Spot, and the late brood of Codling Moth.

1897, experiments with Lysol were continued. Use of arsenate of lead against Codling Moth. Paris green with Bordeaux mixture found as effective as when used alone. Experiments for the prevention of Peach Leaf Curl, Fruit Rot, and Orange Rust of quince. Various formulas tried to destroy aphis.

1899—An experiment was tried to prevent the swelling of the buds of apples, plums, and cherries by spraying the trees with a lime-wash. The effect of this wash on the oyster shell bark-louse was also noted. In this year the horticulturist assisted the chemist in an experiment to destroy mustard by spraying with solutions of sulphate of iron and sulphate of copper.

1900—Experiments with different formulas of lime-wash were made to test their effect in eradicating Oyster-shell Bark-louse and San José Scale.

1901—Further experiments in the eradication of Oyster-shell Bark-louse with lime-washes. Experiments with Bordeaux mixture for the prevention of potato blight.

1902—Experiments with potassium sulphide to check gooseberry mildew. Spraying potatoes with Bug Death, wet and dry, and with Bordeaux mixture for the prevention of blight.

1903—Test of dust sprayer. Experiments with different fungicides for potatoes continued.

1904—Experiments with Bordeaux mixture, Bordeaux mixture and Bug Death and Soda Bordeaux, to control potato blight.

1905—The same fungicides were used for potatoes as in 1904. An experiment was made in conjunction with the Chemist in making kerosene emulsion with lime and with flour instead of soap, and trying the effect of these emulsions on foliage and on aphis.

Spraying calendars prepared by the Horticulturist and the Entomologist were published in 1895, 1897, 1899, and 1904, in which directions are given for making the different formulas recommended, and the time of spraying for each important disease and insect pest.

FORESTRY.

The forest belts at the Central Experimental Farm, comprising about 21 acres, are in the Horticultural Department. In these belts, which contain most of the best native species used for timber, are growing about 23,000 trees. The trees are in blocks of single species and in mixed plantations. The first planting was done in 1887. Measurements are taken each year of the growth and height of certain average trees, and tables showing these have been published from time to time in the reports of the horticulturist.

Until the last few years the trees in the mixed plantations were making the most satisfactory growth, and are still making better growth than some of the trees in clumps of single species, but the rapid growing kinds are developing so fast in the mixed belt that they are overshadowing some of the more valuable trees, and those which cannot endure shade are being killed. To some extent this over shadowing is prevented by clearing the side branches and letting in more light, and by heading back some of the trees of less value. In nature the proper proportion of fast and slow growing shade-enduring and light-needing trees is gradually adjusted as the trees develop, but in artificial planting it is very difficult to arrange them in proper proportion, especially where a large number of species are used. The fewer kinds that

are used the easier it is to plant the trees in the best proportion of each kind of tree.

In some of the clumps of single species the disadvantage of not having two or more kinds mixed is quite as apparent as the disadvantage of having so many kinds mixed in the mixed belt. Ash, butternut, black walnut, and elm, which have thin foliage, do not kill the sod when young, and the growth on this account is checked. If other heavy foliaged kinds, such as larch, spruce, pine, or box elder, had been mixed with these the results would almost certainly have been much better.

The forest belts afford many interesting studies of the relative shade-endurance of different species.

From 1890 to 1894 the distribution of young forest trees, cuttings and scions to the Western provinces was made through the Horticultural Division, and during that time 7,213 packages in which were nearly half a million trees and cuttings were distributed.

ARBORETUM AND BOTANIC GARDEN.

The Arboretum and Botanic Garden which occupies 65 acres of land, has been in charge of the writer since 1895. In 1898 when he became Horticulturist he was appointed Curator of it, since which time it has been included in the Horticultural Division. Previous to 1895 the Arboretum and Botanic Garden had been in charge of Dr. Jas. Fletcher, Botanist and Entomologist of the Dominion Experimental Farms. The collection of trees, shrubs, and herbaceous plants is now very large. In the autumn of 1905 there were 3,229 species and varieties of trees and shrubs, represented by 5,010 specimens; and 2,041 species and varieties of herbaceous perennials. A number of these have doubtless been killed by the winter of 1905-06, but the additions which will be made in 1906, will probably make the number about equal to what it was in the autumn of 1905. This large collection of plants from many parts of the world furnishes a valuable object lesson as to the species which will endure the climate at Ottawa, and also gives a good opportunity for the study of the different species and varieties.

Notes are recorded annually on the hardiness and vigour of the plants, and in the case of the herbaceous perennials their time of blooming, continuity of bloom, colour of flowers and height of plants.

A catalogue of the trees and shrubs in the Arboretum was published conjointly by the Director and the Horticulturist, in which the scientific names of the trees and shrubs are arranged alphabetically with many of the common names, and notes on the relative hardiness of the most of the speciments given. The countries of which the trees and shrubs are native are also published in this bulletin.

The following articles relating to the plants growing in the Arboretum and Botanic Garden have been published in the Annual Reports of the Horticulturist.

1898, List of Additional Herbaceous Perennials, (a list of one hundred of the best had been published in the Annual Report for 1897).

1899, List of Additional Good Perennials. The best low growing shrubs.

1900, A Descriptive List of the Best Woody Climbers.

1901, A Descriptive List of the Different Species and Varieties of Lilacs.

1902, A List of Best Spring Flowering Perennials.

1903, A List of Deciduous Trees, Shrubs and Climbers with Attractive Foliage, Bark and Fruit.

1904, A List of the Genera of Trees and Shrubs in the Arboretum, with the Number of Species of each.

MEETINGS.

Every year the Horticulturist attends such meetings and exhibitions as are thought desirable, and during the past nineteen years a large number of places have been visited in this way. These meetings not only give the Horticulturist an opportunity of bringing before farmers and fruit growers the results of experiments carried on at the Experimental Farm, but bring him in contact with practical men from whom much information is obtained which is suggestive for future horticultural work. Covering, as they do, a wide range of country these meetings also give the Horticulturist an excellent idea of the horticultural conditions in different parts of Canada which enables him to use better judgment than he otherwise would do in assisting fruit growers by the various means in his power.

Correspondence.—The correspondence of the Horticultural Division, which is growing steadily, takes considerable time. The fruit growers of Canada are recognizing more and more every year that the Experimental Farm is a bureau where free information can be obtained, hence questions relating to many branches of horticultural work are received which are dealt with as promptly as possible. The answers to these questions mean much to many fruit growers, and the information thus made available free of cost is much appreciated by them, as frequently expressed in letters of thanks.

PUBLICATIONS OF THE HORTICULTURAL DIVISION.

In addition to the nineteen annual reports by the horticulturist which have been issued, the following bulletins have been prepared since 1887:—

No. 5, 'Strawberry Culture,' August, 1889, by W. W. Hilborn (out of print).

No. 10, 'Treatment of Apple Scab, Grape and Gooseberry Mildew,' April, 1891, by John Craig.

No. 17, 'Cherries,' November, 1892, by John Craig.

No. 22, 'Raspberries,' March, 1895, by John Craig.

No. 23, 'Spraying for the Prevention of Fungous Diseases, Black Knot of the Plum and Cherry,' April, 1895, by John Craig (out of print).

No. 27, 'Strawberries,' June, 1897, by John Craig (out of print).

No. 37, 'Apple Culture,' April, 1901, by W. T. Macoun (out of print).

No. 43, 'Plum Culture,' July, 1903, by W. T. Macoun.

No. 49, 'The Potato and Its Culture,' April, 1905, by W. T. Macoun.

Bulletin No. 1 (second series), 'Peach Culture in Canada,' by John Craig.

Bulletin No. 2 (second series), 'Catalogue of the Trees and Shrubs in the Arboretum and Botanic Garden at the Central Experimental Farm,' June, 1899, by Dr. Wm. Saunders and W. T. Macoun.

MISCELLANEOUS PUBLICATIONS.

Note No. 3, 'Black Knot of the Plum and Cherry.'

Note No. 5, 'Pear Blight.'

Note No. 6, 'Spot or Blight of the Native Plum.'

Note No. 7, 'Tomatoes.'

Note No. 8. 'Top Grafting.'

Spraying calendars in 1895, 1897, 1899 and 1904 by the Horticulturist and the Entomologist.

REPORT OF THE CHEMIST.

FRANK T. SHUTT, M.A., F.I.C., F.C.S., F.R.S.C.

OTTAWA, March 31, 1906.

Dr. WM. SAUNDERS, C.M.G.,
Director Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to submit the accompanying report on the character and scope of the work of the Chemical Division. It is to be regarded as a brief and popular account of the various ways in which it has been sought to assist Canadian Agriculture by chemical investigation during the past 19 years. The writer has purposely omitted data and matter of technical character, desiring merely to point out the nature of the researches undertaken and adding a few illustrations to bring home the practical value of the work.

I have the honour to be, sir,
Your obedient servant

FRANK T. SHUTT,
Chemist, Dominion Experimental Farms.

THE CHEMICAL DIVISION.

The work in the Chemical Division was begun in the autumn of 1887, soon after the establishment of the Experimental Farm system. As at first there was no accommodation suitable for laboratory purposes at the Central Farm, temporary quarters were procured and fitted up in the city of Ottawa, and there chemical work was carried on by the writer until June, 1889, when a removal was made to new laboratories erected at the Farm. These laboratories occupied, practically, one-half of the general office and museum building and furnished substantial accommodation for the chemical work. Experience proved them to be well designed as to convenience, light, etc., for the class of work intended to be undertaken.

An unfortunate accident, resulting in a disastrous fire, occurred in these laboratories in July, 1896. The laboratories were completely gutted and, practically, all the apparatus, tables, etc., destroyed. The most serious loss, however, was in the records and data in connection with investigations in progress and in the samples of Canadian soils and agricultural products, the accumulation of nine years. The laboratories were temporarily fitted up and equipped and work resumed within a few weeks of the fire, but it was thought desirable to erect a separate and fire-proof building which would give still better facilities for chemical work, rather than to permanently refit the disabled laboratory.

Such a building was finally decided upon and built in 1898. It was ready for occupation in August, 1899, and since that date has been in use. The building is of brick with stone basement and trimmings and with pressed brick for the interior finish. It contains on the main floor two laboratories and offices for the chemist and

assistants; rooms for the storage of samples, and for photographic purposes, on the second floor, and store rooms for chemicals and apparatus and grinding and milling rooms in the basement. This building has proved very satisfactory and has, no doubt, been an important factor in facilitating the work of the Division.

The Staff.—For the past seven years the staff has consisted of the chemist, two assistant chemists, an assistant in connection with the clerical work of the Division—acting also as secretary—and a laboratory man to do the grinding, sampling, washing, etc., and who acts as caretaker of the building.

Both in research work and that done more directly for farmers by analysis and correspondence, there has been a continued and marked increase since the establishment of the Division. It is due to this fact that it has not been possible for a number of years to undertake all the investigations thrust upon us. The need for more expert assistance in the laboratory is now very keenly felt and must shortly be supplied unless we are to very materially restrict our field of usefulness.

THE RELATIONSHIP OF CHEMISTRY TO AGRICULTURE.

The relationship that exists between chemistry and agriculture is a very intimate and important one. Modern and progressive agriculture implies and compels the application of certain principles which have chemistry for their basis. So close, indeed, is this relationship that some have said that 'up-to-date farming is merely putting into practice the teachings of agricultural chemistry.' This does not mean that the farmer must be a chemist; any intelligent man can understand the application of these principles without a special study of chemistry. But to-day it is well nigh impossible to carry on successfully any branch of agriculture,—*e.g.,* stock raising, dairying, fruit-growing—without an application of that knowledge regarding soils and animals and plants which chemistry alone furnishes. The requirements of crops and animals, the constitution and the needs of soils, the most economical means whereby soil fertility may be maintained, the nature and amounts of fertilizing ingredients in manures, the relative nutritive value of forage crops and cattle foods, the composition of dairy products, the constitution and preparation of fungicides and insecticides, and a host of similar and equally important questions can only be satisfactorily answered through the aid of chemistry.

THE CHARACTER AND SCOPE OF THE WORK.

In order the better to aid Canadian farming it has been the studied policy from the outset in all the departments of the Experimental Farm system to keep in touch with the farmer. By so doing we have had an opportunity not only of rendering immediate and direct assistance, but also of learning, at first hand, those problems that are confronting the agriculturist in different parts of the Dominion and which require what might be termed scientific aid for their solution.

Our work may, therefore, be said to fall under two great subdivisions: education and investigation, though between these there is naturally no sharp line of demarcation. The channels through which information is chiefly disseminated are as follows.

CORRESPONDENCE.

Letters are received daily in which questions are asked relating to soils and their treatment; manures and fertilizers, their composition and use; cattle foods; insecticides, dairy products, &c., &c. This branch of our work has steadily grown, and this fact betokens, I believe, an increasing and fuller appreciation on the part of the practical farmer of the value of chemical knowledge. The education of the individual is

often the necessary preparatory step towards the education of the community, and it is this belief that has led us to encourage this branch of our work, though frequently it must be prosecuted at the expense of investigation and research. There is undoubtedly a keen and widespread desire for accurate information on farming matters and the Experimental Farm strives to furnish it.

LECTURES AND ADDRESSES.

Undoubtedly a most important part of our work is in the giving of addresses at agricultural conventions and meetings of farmers. By this means not only is knowledge disseminated, but we come into personal contact with many of the best farmers, dairymen, fruit growers, in the Dominion, thus enlisting their co-operation, which is so necessary for the furtherance of our work. At the same time we have an opportunity of learning, as we could in no other way, the peculiarities, and possibly the special difficulties, that may prevail in different parts of the country and which subsequently furnish material for research.

PUBLICATIONS.

A concise account of each year's work, written in language understandable by the farmer, appears in the Annual Report, nineteen of which have now been issued and distributed throughout the Dominion. Many of the special investigations are written up and sent out in bulletin form. These bulletins are issued from time to time as the researches are completed or brought to such a stage that the results obtained are of value to agriculturists. Reference to several of those written by this Division will be made later when speaking more particularly of the original research we have undertaken.

Evidence is given yearly before the Standing Committee on Agriculture and Colonization of the House of Commons on the work of the Division, and this receives a limited distribution through the members of the House and is also widely copied by the press.

In this connection, mention should not be omitted of the valuable agency of the Canadian press, and especially that devoted to agriculture. The use of their columns has always been available to us, and this opportunity of quickly reaching the reading farmer has frequently afforded a valuable means for disseminating knowledge of a timely character.

SAMPLES SENT IN BY FARMERS FOR EXAMINATION.

In order to make the Division as practically useful as possible we have examined and reported upon samples of an agricultural nature forwarded by farmers. These are received from all parts of Canada, and include soils, naturally-occurring fertilizers —such as mucks, marls, seaweed, &c.—forage plants and cattle foods, well waters, dairy products and insecticides. As far as time permits and occasion demands, these are examined chemically and microscopically. The greater number of these can only receive a partial analysis, but in every case we endeavour to make such determinations as will furnish useful information to the sender. Between 500 and 700 of such samples are received yearly, and an account of those which afford information of general interest is given in the annual report.

INVESTIGATIONS AND RESEARCHES.

Naturally, our chief and most important work is in carrying out by the aid of chemistry such investigations as may serve to solve those problems in Canadian agriculture which more or less affect the country in general. In the limited space allotted to this report it would be quite impossible to mention even briefly the many researches

that have been undertaken, much less to state in any detail the results obtained therefrom. All that can be attempted here, therefore, will be an outline of some of the more important pieces of work completed and in hand that may serve as illustrations, referring the reader to the various publications of the farm for fuller particulars.

CANADIAN SOILS.

There is probably no factor that plays a more important part towards profitable farming than a productive soil, and all will admit that the agricultural wealth of a district is very largely measured by the nature of its predominating soil. It is obvious, therefore, that the determination of the agricultural value of a soil (as far as may be obtained from chemical analysis), and especially of soils from new areas and those about to be settled, is often a matter of the greatest importance. It is this view that has led us to examine certain typical and virgin (uncropped and unmanured) soils of Canada, collecting the samples carefully and as far as possible having them representative of large areas, so that the results could be made widely useful.

Since 1887 over 200 such samples, comprising surface and subsoils, have been submitted to complete analysis. Among these are soils from every province in the Dominion, though naturally the greater number are from Manitoba, Saskatchewan, Alberta and British Columbia. The results from the first ten years' work in this matter were incorporated in a paper presented to the meeting of the British Association for the Advancement of Science, held in Toronto in August, 1897, and subsequently printed *in extenso* in the Experimental Farm Report for that year. From that date on the work has been published as finished in the report of this Division.

The writer is well aware that a soil's fertility consists in something more than its plant food, and has never claimed that a chemical analysis is all that is sufficent for making a correct diagnosis of a soil's crop-producing power. Nevertheless, such an examination as furnishes the percentage of nitrogen, phosphoric acid, potash and lime present would show what deficiencies, if any, in the soil elements essential for plant growth, existed, afford valuable information regarding the suitability of the soil for various farm crops and indicate the direction in which fertilization may be profitably carried on.

In addition to the usual 'complete soil analysis,' using strong, hot hydrochloric acid as a solvent, we have since 1894 adopted the Dyer process (solvent: 1 per cent citric acid) for estimating available plant food. By this method it has been shown possible to obtain, approximately, the proportions of the mineral constituents that are more or less immediately available for crop growth. The results thus obtained have been found of particular value in diagnosis, especially as regards the immediate needs of the soil.

As it is quite impossible here to review this work on Canadian virgin soils without omitting very much that is essential to a correct judgment of their value, it must suffice to record the fact that we have obtained ample proof that large areas are to be found in almost every province covered with virgin soil containing an abundance of those materials which crops draw upon directly, and farm animals indirectly, for their sustenance and growth. This is particularly the case in the provinces constituting what is known as the great Northwest of Canada, where undoubtedly exist some of the richest soils in the world. It would seem that thousands upon thousands of acres of magnificent soil yet await the husbandman in that part of the Dominion.

Naturally, there are many classes or types of soils in Canada. Among them, of course, some that are of medium fertility, some poor, others very poor. Perhaps it is to those occupying lands of only moderate productiveness that our work in this connection has been the most useful, since we have always laid special stress upon the most economical means of increasing soil fertility.

THE IMPROVEMENT OF MUCK SOILS.

Large deposits of swamp or black muck occur in Ontario and the eastern provinces, as well as in British Columbia. The reclamation of these swamps and the conversion of the muck into a fertile soil are consequently matters of considerable importance, though not infrequently found to be problems of great difficulty. Thorough drainage is, of course, necessary at the outset to get rid of the excess of water and allow aeration, indispensable for correcting the sourness so characteristic of the native muck. The settling also that follows drainage vastly improves its mechanical condition.

For the past twelve years experiments have been conducted in connection with the improvement of such soils, and our experience goes to show that while the same general principles are applicable to all, a considerable amount of experimental or trial work must be done on the area about to be reclaimed before the most effective method can be ascertained. Our experiments have included : (1) the addition of sand and clay, singly and together. Many mucks by this treatment have been converted into excellent loams, the improvement apparently being largely due to the mechanical alteration of the soil; (2) The addition of the mineral constituents of plant food—potash, phosphoric acid and lime. These have been applied in the form of potash salts (muriate, &c.) and phosphates, separately and in admixtures. Wood ashes also have been tried, as well as simple dressings of lime. Most encouraging results in the majority of instances have been obtained from thus supplying the lacking mineral elements, and especially from the application of those mixtures which by their alkalinity serve to neutralize the muck's acidity; (3) An application of stable manure or good loam. Although muck is practically organic matter and is rich in nitrogen, it has been found that at the outset (and after the drainage and settling of the muck) such an application has proved very beneficial. This, we conclude, is due rather to the introduction of desirable soil bacteria than to the small amounts of plant food thus supplied.

THE VALUE OF LEGUMES FOR THE IMPROVEMENT OF SOILS.

If the crop-producing power of a soil is to be maintained or increased, due regard must be given to cultivation, rotation and manuring. These are the means whereby a favourable physical texture is assured and a supply of immediately assimilable plant food is obtained. In connection with the last mentioned of these factors, this Division has been specially engaged for the past fifteen years on the study of the legumes as soil enrichers. Almost every possible phase of the subject has been investigated.

The particular value of the legumes (clover, alfalfa, peas, beans, &c.), for manurial purposes lies in the fact that they are able to appropriate and store up free nitrogen from the atmosphere. This they are enabled to do through the agency or co-operation of certain germs or bacteria present in the soil, and which attaching themselves to the roots of the legumes form thereon nodules or tubercles in which they subsequently reside. The nitrogen of the air in the soil is absorbed by these germs, elaborated into nitrogenous compounds and passed on to the circulation and tissues of the host plant—the legume. On turning the crop under, the natural decomposition that follows enriches the soil in compounds that will, under favourable climatic influences, subsequently furnish nitrogen in forms available for plant growth, and thus increase in the yield of succeeding crops. The benefit to be derived from green manuring' (as this use of the crop is termed) is not confined to this addition to the soil's nitrogen content—there is the production of a large amount of humus-forming material with all its valuable functions, chemical and physical, and the setting free in a pre-digested form of considerable amounts of the mineral constituents of plant food.

Voluminous data have been obtained as to the relative values of the more commonly grown legumes as fertilizers from the standpoint of their nitrogen-content. The list includes Common Red Clover, Crimson Clover, Alfalfa, Hairy Vetch or Sand Vetch, Peas, Soja Beans and English Horse Beans. In this work, in addition to the analyses, the weights per acre were also taken of the foliage and of the roots (to a depth usually of 9 inches) separately, so that the manurial value of the roots could be estimated when the crop was cut and cured. The reader is referred to the reports of this Division and to a bulletin issued in 1902 by the Director and the writer entitled 'Clover as a Fertilizer,' for further details of this valuable research. It may be briefly stated, however, that the evidence shows that from 75 to 150 lbs. of nitrogen per acre can be added to the soil by this means of 'green manuring.'

Experiments of a somewhat more direct nature than the foregoing have also been made, viz.: the analysis of the soil before and after the growing of clover. The results are of a very satisfactory character, indicating that a very large proportion of the nitrogen-holding organic matter from the turned under clover becomes part and parcel of the soil.

The value of clover as a fertilizer has also been ascertained by determining the increase of yield of various farm crops following the growth and turning under of clover. Many series of such experiments have been made during the past fourteen years under the immediate supervision of the Director. These field tests have confirmed in the most emphatic manner the results obtained by chemical research and have proved beyond dispute the great benefit to be derived from the legumes as soil enrichers.

INOCULATION FOR THE GROWTH OF LEGUMES.

For several years we carried on experiments, both in pots and in the field, with cultures or preparations of these nitrogen-fixing bacteria, using both seed and soil inoculation. At first the cultures prepared in Germany, and known as Nitragin, were tested. It was shown that in certain instances the cultures had distinctly favoured the growth of the legumes, but their action was more or less uncertain, and we concluded that there was not sufficient evidence to justify us in recommending this preparation for general use. These cultures (there being at that time 17 in all upon the market) were found particularly susceptible to light and heat, and under the best conditions of preservation their vitality could only be guaranteed for six weeks from the date of preparation. It was felt, therefore, that the matter was still in the experimental stage and that further investigation and more satisfactory results would be necessary before the process could be considered one of practical utility.

More recently, the new cultures of Dr. George T. Moore, of the Bureau of Plant Industry, Washington, D.C., U.S., have been tried. These it was claimed were more potent and less susceptible to unfavourable conditions than the German cultures by reason of special modification in the method employed in their preparation. Our results were not, on the whole, satisfactory, and though in certain instances larger yields were obtained from the inoculated crop than from the untreated crop grown under similar conditions of soil and climate, the effect was either so uncertain or so slight that we did not feel justified in reporting favourably on the cultures for general use. It is quite possible, however, that in certain isolated areas inoculation is valuable in inducing a more vigorous growth of clover and alfalfa. For such areas we believe that the most direct and surest plan is to secure soil containing the bacteria, i.e., from a field that has recently grown clover or alfalfa, and either to broadcast it on the field to be treated, and thoroughly harrow in, or to place the bacteria-holding soil in a vessel (tub or barrel) and pour on water. After stirring and allowing to stand a little time, decant the supernatant soil extract and thoroughly moisten therewith the seed of the legume. This treated seed should be sown as soon as it is sufficiently dried.

Experience and observation have led us to conclude that inoculation is not so generally necessary as is claimed by some authorities. If we may judge from the occurrence of nodules, it is certain that the nitrogen-fixing bacteria are by no means restricted to small or isolated areas. In the eastern provinces and in Ontario and British Columbia, at all events, we believe that failures to obtain a good catch of clover have been due rather to deficiency of moisture, poverty in humus, sourness, insufficient drainage or an unsuitable mechanical condition of the soil, than to the absence of the nitrogen-fixing bacteria.

CONSERVATION OF SOIL MOISTURE.

Concurrently with much of the experimental work in connection with the value of legumes for soil enrichment, the effect of various methods of cultivation upon the soil's moisture content has been ascertained. The determinations have been carried on with several classes of soil and under various conditions of season on the Experimental Farms, Ottawa, Ont.; Nappan, N.S.; Brandon, Man.; and Indian Head, Sask. The experiments in the North-west demonstrated the value of summer-fallowing in conserving moisture for the succeeding crop, and those conducted in Ontario and the eastern provinces have given data of particular value for the management of orchard soils.

NATURALLY-OCCURRING FERTILIZERS.

The reports of this Division abound in analyses of muck, marls, river and tidal deposits, sea-weed, and many other materials of fertilizing value found in various parts of Canada. The information furnished with regard to their value and rational uses has, we believe, assisted many farmers in the economical improvement of their land.

PRESERVATION OF BARNYARD MANURE.

We have undertaken to estimate the losses that follow upon various methods of preserving manure, under summer and winter conditions respectively. These losses may arise from two causes, fermentation—which means destruction of organic matter and dissipation of nitrogen—and leaching, whereby the stores of soluble plant food, both organic and mineral, are materially lessened by drainage.

The details of the first series of experiments were published in the report of this Division for 1898 and in Bulletin No. 31. The extent of the loss was found to be dependent upon the conditions of rotting the manure and the degree and the length of time in rotting. Undoubtedly, if manure cannot be put while fresh into the soil the ideal arrangement is to keep it in a moist, compact pile, protected from rain. Thus, in an open shed, mixed horse and cow manure, lost during three months exposure 60 per cent of its total organic matter (humus-forming material), 30 per cent of its total nitrogen, and 22 per cent of its total potash, and 8 per cent of its total phosphoric acid. Similar manure, but protected by being kept in a roofed shed, lost during the same period 50 per cent of its total organic matter and 15 per cent of its total nitrogen, the phosphoric acid and potash suffering no loss, as there was no leaching. Though for certain specific purposes rotted manure has undoubtedly advantages over fresh manure, it must be pointed out that for general farm purposes the losses in rotting outweigh the benefits therefrom. The safest storehouse for manure is the soil, and we, therefore, unhesitatingly say that the farmer who gets his manure while still fresh into the soil returns to it for the future use of his crops much more plant food than he

would if he allowed the manure to accumulate in piles that receive little or no care and which, therefore, must waste by excessive fermentation or leaching, or both.

While ground gypsum (land plaster) can undoubtedly be used with benefit in the stable to absorb or fix the ammonia so readily and rapidly formed from the urine, our experiments would make it apparent that when added directly to the manure pile, its action in preventing loss of nitrogen is extremely feeble.

The question is frequently asked: if manure spread upon the field dries before it is ploughed under, what loss, if any, is there of its nitrogen? Experiments conducted to ascertain information on this point showed conclusively that when manure is spread in thin layers and allowed to dry out, fermentation is rapidly arrested, and that the loss from volatilization of the ammonia is very small and may be disregarded unless the manure is in a state of exceedingly active fermentation when spread upon the field.

The most recent experiments in the preservation of manure have been those undertaken to learn what changes or losses occur during the winter months when manure is piled in large heaps (about 12 tons) and small heaps (about 600 lbs.) respectively. The results from this series are not yet ready for publication, but it may be stated that the data furnish most satisfactory evidence that there is no appreciable loss so long as the method of piling and the temperature ensure that the manure remains frozen Under the climatic conditions prevailing at the time when the experiment was begun (January) the fermentation of the manure in the smaller heaps was immediately arrested, the manure freezing solid within 24 hours. In the larger heaps, however, fermentation was only temporarily checked on the outside, and after a few days proceeded with vigour, resulting in great loss of humus and nitrogen.

If, on the other hand, when the large heap is made by daily additions, and the temperature is such that each application of manure is frozen before the succeeding one is put on, no fermentation ensues. The frost gradually left the heap as spring advanced, but at the time when it was considered desirable to spread the manure there had been no heating.

FORAGE CROP: GRASSES, RAPE, INDIAN CORN, ETC.

The relative value from the feeding standpoint, of the larger number of the native and introduced grasses has been ascertained. The analyses, in all about 200, have enabled us also to advise as to the stage of growth or period at which grasses should be cut for hay, for we have traced by chemical means the general changes that take place in their composition as they approach maturity. In the majority of instances the fact was well brought out that there was a serious deterioration during the latter stages of the plant's life, pointing to the desirability of cutting before the seed has been fully ripened. Examination of many native grasses from the prairies of Manitoba and the Northwest showed that they were highly nutritious and that the naturally cured grasses possessed valuable feeding qualities.

A very thorough study of the chemistry of the Indian corn plant as grown for the silo has been made. This work extended over several seasons and included the examination of several varieties (both Dent and Flint), the determination of the changes in food value at several stages in the plant's growth, and the effect of sowing broadcast, and in drills and in hills. Many lessons of practical value are to be learnt from the results of this investigation, *e.g.*, the desirability of planting varieties that will sufficiently mature before frost; the necessity of plenty of room, both above and below ground, for the steady, vigorous development of the plant—and hence the folly of sowing broadcast; the benefit to be derived by allowing the corn to come to the 'glazing' stage before cutting. These, and many other points of practical interest, were brought out by this research.

In much the same way the life history of rape, sugar beets and other crops has been followed up, sometimes with the view of tracing the feeding value at various

stages of growth; at others, to ascertain the extent to which the crop exhausted the land and afford data for a rational treatment of the soil with manures and fertilizers.

SUGAR BEETS.

Since the establishment of the Experimental Farms we have, season by season, estimated the sugar content and "purity" of varieties of sugar beet specially grown for factory purposes. The examination has included beets grown in every province in the Dominion. It is impossible to generalize in a sentence or two the voluminous data we have accumulated—the season, the seed, the soil, and the culture, each has its marked effect on the richness and purity of the beet. It may be stated, however, that ample evidence, has been placed on record that beets eminently suited for factory purposes can be grown in many parts of Canada.

CANADIAN CEREALS.

The growth of Red Fife in the Canadian Northwest has earned for the Dominion the enviable reputation of being one of the finest wheat-producing countries in the world. Admitting the very high quality of the flour from the Fife wheats, both red and white, there remains an important field for experimentation in the production of earlier ripening varieties, better suited to northern portions characterized by a short season. This, and similar problems, led to a large amount of careful work being done in the breeding of wheats, work commenced in the early days of the experimental farm by Dr. Wm. Saunders and his associates, and in later years continued under the charge of Dr. C. E. Saunders, Cerealist. Concurrently with this research chemical and physical analyses have been made of the cross-bred wheats so originated, principally with the view of tracing from the composition of the wheat the effect of cross-breeding and of environment or soil and climatic conditions. The results have proved of considerable assistance in discriminating between the many wheats produced from the work of hybridization.

There has also been a hope that the investigations with wheats and flours in the laboratory might lead to the establishment of some chemical basis for determining the bread-making value of a flour that might accord more closely than is now possible with the results from milling and baking tests. The publications of this Division show that certain data of an encouraging nature have been obtained, but it must be admitted that this difficult problem has not yet been satisfactorily solved.

The occurrence or development of soft or piebald wheat in certain districts of the Northwest, and more particularly on new land recently cleared of scrub, is a matter regarding which there has been much controversy. The cause of this development of starchy grains is not at present understood, and many theories have been advocated to account for this deterioration. It seems in some way to be the result of environment, i.e., soil and climatic influences, and connected with the growth and ripening of the wheat plant. A series of experiments has been instituted (and is now in progress) in the hope of obtaining some light upon the peculiar conditions that bring about the changes, and already results of great interest have been secured, indicating that a large supply of soil moisture, especially when associated with an abundance of available food, is an important factor in producing this piebald wheat.

THE INFLUENCE OF SMUT PREVENTIVES ON THE WHEAT GERM.

With a view to determining the relative feeding value of Canadian grown cereals, numerous analyses of oats, barley, emmer, spelts, rye, and buckwheat have been made, and in this connection it may be mentioned that the composition of a large number of

milling by-products has been determined—there being a great demand on the part of dairymen and farmers for information on this subject. The number of such feeds upon the market is constantly on the increase—some are valuable, and again others are worthless. The chief difficulty lies in that a mere inspection very frequently can give no indication of their value.

The action of smut preventives, chiefly solutions of copper sulphate and formalin, on the vitality of wheat has been investigated. This is a matter of great interest and importance to the farmer in the Northwest, who is very anxious to have his seed grain clean and free from smut without having its vitality to any extent impaired. It would seem that of the many solutions, of varying strength, experimented with, the two following are best worthy of recommendation: Copper sulphate 1 lb. to 8 gallons, and formalin 4½ ozs. to 10 gallons, the treatment being thorough sprinkling or immersion for five minutes, drying the grain and sowing as soon as possible.

INVESTIGATIONS RELATING TO DAIRYING.

These have included chiefly examinations of butter-making processes, of apparatus for the testing of milk and butter, and the analysis of Canadian cheese and creamery butter.

Illustrations of the application of chemistry to dairying are given in the following recent bulletins by this Division and issued from the Dairy Commissioner's Branch: Bulletin No. 4, giving the analysis of 105 samples of Canadian creamery butter and furnishing evidence that as regards percentage of water such butters are well within the limit allowed by English and Canadian law.

Bulletin No. 6, containing the results of investigations as follows: The examination of milk preserved by hydrogen peroxide; a critical study of the butter-making process of James Estep; the composition of 'milk powder' from the evaporation of whey; the volatile acid content of fat from 2-year old cheese, and the testing of recently devised apparatus for the determination of water in butter.

Bulletin No. 8, in which are given the data from a series of experiments undertaken to determine the principal factors that control the water-content of butter.

The enumeration of these titles may serve to make clear the character of this work and the many and important ways in which chemistry has assisted Canadian dairying.

THE CHARACTER AND CAUSES OF SOFT PORK.

Of the qualities necessary for first class export bacon, firmness is the highest in importance. A tendency to softness seriously reduces the price in the English market, and if pronounced may altogether make the bacon unsaleable at a profit. As a certain proportion of the pigs received at the Canadian packing houses produced 'soft' bacon, it became highly desirable some years ago to investigate the cause and, if possible, suggest a remedy. An investigation was, therefore, undertaken which lasted three years. It was made as comprehensive as possible, and included a large number of feeding tests. The bacon from these pigs (in all, over 300) was critically examined and subsequently submitted to analysis—it having been shown at an early stage in the research that chemical analysis furnished data of a very satisfactory nature as to the character of the fat. The softer the bacon the larger proportion of olein in its fat. Bulletin No. 38 (Experimental Farm Series) gives an exhaustive account of these experiments and the results obtained, and it will, therefore, only be necessary here to say that it was found that the one great controlling factor in the quality of the finished pork lies in the character of the food employed; that Indian corn meal and bean meal cannot be fed in large proportions without injuring the quality of the pork, *i.e.*, increasing the softness of the fat; and thirdly, no better

corrective for softness was found than skim milk, the addition of which to the grain ration also tended to thriftiness and rapid growth.

The results of this research cannot be condensed into a few paragraphs and, therefore those interested in the subject are referred to the publication above mentioned. It is gratifying to know that the packers state that the percentage of 'soft' hogs has materially decreased since the dissemination of the results of this investigation.

INVESTIGATIONS RELATIVE TO FRUIT GROWING.

In this field the work has been exceedingly varied. Thus, we have fully studied the chemistry of the apple, strawberry, and some other fruits with a view of learning their particular needs and the rate at which they may exhaust the soil of plant food. Again, much time has been given to the matter of fungicides and insecticides—their preparation and safe application. Finally, in the management of orchard soils much information of value has resulted from experiments with cover crops as to enrichment of the soil and the conservation or dissipation of its moisture.

WELL WATERS FROM FARM HOMESTEADS, CREAMERIES AND CHEESE FACTORIES.

Samples of this character have been analysed free of charge (*) with the object of awakening an interest in pure water. The importance, indeed the necessity, of a good supply of wholesome water has been annually urged upon the farming community and the danger, both to the family and the stock, from polluted water repeatedly pointed out. As a result of this campaign there is now-a-days much greater care and attention given to the rural water supply, and backdoor and barnyard wells are being abandoned for more distant and purer sources. More than two thousand samples have been analysed since the opening of the laboratories, and though the results may have little scientific value, the work has been of great practical importance and benefit.

In bringing to a conclusion this hasty view of the work of the Chemical Division during the past nineteen years, the reader is again reminded that this is not a condensed or concise report of all that has been accomplished, it is rather to be considered as a presentation of certain illustrations which should be representative of the character and scope of the chemical work. There seems to be no branch of agriculture that cannot be assisted by chemistry and the aim has constantly been to attack those practical problems which appeared most pressing, leaving aside for the time those researches of more purely scientific interest. The field has been found to be wide and varied and though much has been done, much more remains to do. It has been, and is, a work of national importance and we venture to say that the progress of Canadian agriculture will in a large measure be proportionate to the continued aid given by the chemical and other scientific branches of the agricultural reseach institutions of the Dominion.

* Certain directions (supplied on application) must be followed in the collection and shipment of the sample and express charges prepaid.

REPORT OF THE ENTOMOLOGIST AND BOTANIST.

JAMES FLETCHER, LL.D., F.R.S.C., F.L.S.

OTTAWA, April 1, 1906.

DR. WILLIAM SAUNDERS, C.M.G.,
Director of the Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to hand you herewith an interim report for the four months which have passed since the date of my last annual report, until the beginning of the present new fiscal year.

The time of the officials in the Division of Insects and Plants was given, necessarily at that time of the year, to office work and addressing agricultural meetings. The first thing to be attended to was the preparation of the annual report for the year ending November 30, 1905. This together with the correspondence took the whole time of the staff until the Christmas holidays. Subsequent to that time the usual routine of the Division for that season of the year was carried on vigorously. This is the time of the year when the collections of the previous season and specimens received from correspondents and other outside sources have to be mounted and arranged.

COLLECTIONS.

The collections in the Division, both of insects and plants, have been considerably increased, and during the past winter many additions have been put in place. The botanical collections are in the charge of Mr. J. A. Guignard and Mr. Arthur Gibson is the curator of the entomological specimens.

1. *Insects.*—Much progress has been made in arranging the entomological cabinets. The large and important family of Noctuidæ, the caterpillars of many of which are the injurious cutworms, so well known to farmers, is now very well represented in our cabinets, and with the assistance of correspondents in all parts of Canada, added to special efforts of the officers, this collection is now a most valuable source of reference to those who wish to know the appearance of the moths which produce these caterpillars which every year in some part of Canada are the cause of so much loss to farmers and gardeners. This collection too is rendered very much more serviceable for this purpose by the large number of larvæ it now contains skilfully inflated by Mr. Arthur Gibson. Frequent reference is also made to the collections by students, more of whom every day are becoming interested in the important study of insects, a knowledge of which has saved so much to growers of crops and flowers. As in previous years many specimens of insects have been sent in by students for identification. This is a useful part of our work by which not only is the study of entomology helped, but much useful information is gained as to the distribution of species, and many acceptable specimens are secured for our cabinets.

2. *Plants.*—A large number of new sheets of mounted specimens of plants have been put into their places in the Herbarium, and good progress has been made in pushing forward a card index of the collection, in which each specimen is recorded, giving the name, the place and date of collection, and the name of the collector, or contributor. A separate collection has also been made, for use at farmers' institute meetings or for easy reference by visitors, of the weeds and weedy plants of Canada. The collection of weed seeds has also been re-arranged and although the cabinet in

which they are contained is a small one, the collection is now fairly complete and of great value in the work of the Division. There are represented the seeds of nearly all the Canadian weeds which are troublesome in crops and also of those plants which it is thought may at some time become so. In addition we have a good representation of those seeds of dangerous plants which are occasionally found in crop seeds imported into the country through the regular channels of commerce, either with other seeds, in packing used for merchandise, or even intentionally as plants to be cultivated for the beauty of their flowers, or for food. These two last named classes are by no means unimportant as will be amply illustrated by the fact that Purslane (*Portulaca oleracea,* L.) is extensively used in France as a pot herb, as well Crantz) is much used in Germany for the sake of the copious mucilage on the seeds. as the Dandelion (*Taraxacum officinale,* Weber), and False Flax (*Camelina sativa,* The seeds of all of these plants have been imported into this country for domestic use; while the Orange Hawkweed (*Hieracium aurantiacum,* L.), the Cypress Spurge (*Euphorbia Cyparissias,* L.) and the Cow Cockle (*Saponaria Vaccaria,* L.) have all been grown as garden plants, the first two being commonly planted in cemeteries from which they have escaped and become very troublesome weeds in some districts. The last named is an abundant and troublesome weed in the grain fields of the prairie provinces to which it was probably introduced, mixed with flax seeds. This collection of weed seeds has been of frequent use in the Division in showing visitors the appearance of weed seeds with which they were not familiar, and also to the officials of the Division in identifying the very large number of weed seeds which are sent in for identification and report by seedsmen, farmers, and others. The seeds of each separate species are cleaned and placed in 8 oz. screw-necked bottles, together with some of the perfect and unbroken pods or seed heads as they occur in nature. Care is also taken to have in each sample, seeds in various stages of ripeness, so as to show the difference between plump, mature seeds and shrivelled unripe ones. Where seeds vary considerably in appearance, two or more bottles are given to a species and each bottle is labelled with the name of the plant represented, the locality and date where collected and also the name of the collector, or the origin of the seeds. The various species are arranged alphabetically by their botanical names in the various natural orders of plants.

CORRESPONDENCE.

The correspondence of the Division during the four months covered by this report shows that from December 1, 1905, to March 31, 1906, the number of letters, exclusive of circulars, was as follows: Received 990, and despatched, 895.

MEETINGS.

December 14, 1905: Richmond, Que.—The Pomological and Fruit-growing Society of the Province of Quebec held their annual meeting on the above date, and the Entomologist attended and delivered two addresses on 'The Injurious Insects of 1905 in the Province of Quebec,' and 'House Plants, their care and propagation.'

January 5, 1906: Lindsay, Ont.—Collegiate Institute lecture course: 'Nature Study and Natural History.'

January 10 to 12.—Ottawa, the Dominion Forestry Convention. This important and successful meeting was attended by the officers of the Division, and a plea made for the study of forest entomology.

January 14 to March 7.—The Entomologist and Botanist left Ottawa immediately after the Forestry Convention, and took part in the work of the Seed Selection Special train, which traversed all the lines of railway in Manitoba and the Northwest Provinces, holding one-hour meetings at all the more important wheat-shipping points. The lecturers treated of those subjects which it was thought would be of the greatest use in helping farmers to overcome some of the obstacles which had prevented them

from getting the fullest returns for their labours from the bounteous crops of the past few years. This subject is treated of more fully further on in this report.

APIARY.

There is little work to be done in the apiary during the period covered by this report, as the bees are hibernating in their winter quarters. The work is still in the hands of Mr. John Fixter, who gives much information to visitors who come to the Central Experimental Farm for advice concerning all matters conected with the keeping of bees.

NEW FISCAL YEAR.

It is now almost twenty years since the Dominion Experimental Farms were established, and as the change in the dates of the limits of the fiscal year will for the future agree with the summer or working season for out-door investigation, the observations of the current season will be reported upon in the next report. For the above reason the present time would seem a convenient occasion to look back over the work which has been done in this Division since its organization. I therefore submit herewith a short *resumé* of what has been done since the Division was entrusted to me on July 1, 1887. Great progress has been made in the practical application of the sciences of entomology and botany to the requirements of the agriculturist and fruit-grower in these two decades, and I trust that it may be considered by Canadians that the results obtained in the Division of Entomology and Botany of the Dominion Experimental Farms may compare favourably with those secured at similar institutions in other parts of the world.

I have the honour to be, sir, your obedient servant,

JAMES FLETCHER,
Entomologist and Botanist.

DIVISION OF ENTOMOLOGY AND BOTANY.

THE PROGRESS OF PRACTICAL ENTOMOLOGY IN CANADA.

The first record we have of a systematic effort in Canada to make known the habits of injurious insects was in 1856, when the Bureau of Agriculture for Upper and Lower Canada offered three prizes of £40, £25 and £15 for the best essays on the 'Origin, Nature and Habits, the History of the Progress from Time to Time, and the Cause of the Progress of the Weevil, Hessian Fly, Midge and such other insects as have made ravages on the wheat crops in Canada; also on such diseases as the wheat crops have been subjected to, and on the best means of evading or guarding against them.' Twenty-two essays were submitted, and the first prize was awarded to Prof. H. Youle Hind, of Trinity College, Toronto, and the second to the Rev. George Hill, of Markham, Ontario. These essays were published by the government and widely distributed.

Practical or applied entomology, as a recognized branch of agriculture and horticulture, may be said only to have had its beginning in Canada in 1865, when the Hon. George Brown engaged the Rev. C. J. S. Bethune to write a series of articles on insects for regular publication in *The Canada Farmer,* a paper published in Toronto. This series was continued for eight years, and gave a large amount of information upon noxious and beneficial insects to the farmers and fruit growers of the country. In 1868 appeared the first number of the *Canadian Entomologist,* now so well known

all over the world as a carefully edited magazine of accurate information on scientific and economic entomology. Ever since that date it has been issued regularly under the able editorship of the Rev. C. J. S. Bethune, or Dr. William Saunders, now the Director of the Dominion Experimental Farms system.

The next conspicuous landmark in the progress of applied entomology was in 1870 when the Agricultural and Arts Association of Ontario voted a sum of $400 to the Entomological Society of Ontario, which had been founded in 1862, on the condition that they would 'Publish an annual report and form a cabinet of insects useful or prejudical to agriculture and horticulture, to be placed at the disposal of the Association.' The Entomological Society of Ontario accepted the grant and has since that time faithfully carried out the conditions, and has continued the work in a most successful manner in tracing out the life-histories of noxious and beneficial insects and devising and making known practical remedies for the former. It has also published every year from 1871 an invaluable report upon occurrences of the injurious insects which were of most importance as affecting the welfare of the province. The first of these reports entitled 'The First Annual Report on the Noxious Insects of the Province of Ontario,' was prepared by Rev. C. J. S. Bethune, Mr. William Saunders, then of London, and Mr. E. Baynes Reed. All of these investigators have from that time to the present day continued their useful labours on behalf of the society and the country at large.

In 1883, Dr. William Saunders's useful work on 'Insects Injurious to Fruits' was published and from that time to the present it has held the first place as a useful manual of accurate scientific information and practical advice to all who may require to know about the insects which attack fruits of all kinds. This work is a model of simply expressed facts prepared for the use of those who have no special scientific training. A second edition appeared in 1892.

Up to 1883, there was no official entomologist connected with the Federal Government, but in that year, the writer was requested by the Minister of Agriculture, the Honourable J. H. Pope, to examine for the department a large collection of seeds and other produce which had been returned from the Philadelphia Exhibition. These were found to be infested by weevils and other insects which it was thought might be introduced into the country in that way. In the same year the writer was asked to act as honorary entomologist to the department. In 1884 the title of Dominion Entomologist was conferred on him and a short report was published on the investigations of ravages committed by insects among farm and garden crops and on fruit and forest trees. In 1884 the Dominion Entomologist made, at the instance of the Minister of Agriculture, a visit to the Northwest Territories, to examine into the condition of the crops and to note any injuries by insects. In 1885, the following year, he also went to British Columbia and spent two months on Vancouver Island investigating injurious insects.

While there he met farmers and fruit growers and addressed them upon the insect enemies of their crops. The work of this season was published as a separate report of 51 pages. This report was drawn up in much the same form as those which the writer has had the honour of submitting year by year since that time, as Entomologist and Botanist to the Dominion Experimental Farms, a position to which he was transferred from the Library of Parliament on July 1, 1887.

Since the time of that appointment there has been a remarkable advance in the knowledge, not only of the scientific study of insects, but in its practical application to the requirements of all lines of business; but most particularly to horticulture, and agriculture, which latter has been styled 'the oldest of the arts and the most recent of the sciences.' At the present day it may be said that any farmer, whatever his special line of work may be, who knows nothing of the sciences which deal with insects and plants, is very poorly equipped to make a success of his calling. It is not suggested that it would be well for a farmer or fruitgrower to be a scientific entomologist or botanist unless he had a special bent of mind in that direction; but it is claimed that an accurate knowledge of the nature and habits, including the time of development

through their various stages, both of the common noxious insects and of plants which may become weeds, is a specially valuable equipment for every one engaged in the cultivation of crops of all kinds.

GENERAL WORK OF THE DIVISION.

Ever since the organization of the Division of Entomology and Botany, an object of special effort has been to convey in the simplest and plainest language to farmers and others for whose benefit all of the investigations are carried on, such results of our work as are considered valuable and worthy of publication. In order that these results and any suggestions made might be practical, no opportunity has been lost of testing personally any remedy or implement recommended for use, and a special feature from which such success as has been attained is largely due, has been the enlisting of the sympathies and securing the co-operation of practical farmers and horticulturists all over the country. It is manifest that none are so likely to take notice of the results of any treatment suggested as those who are actually concerned in a monetary way, in the success or failure of experiments. Many original investigations into the life-histories of injurious insects have been carried on every year since the work began, and much of value has undoubtedly been learnt; but what is perhaps of more value is that concise accounts of the various insect pests and of the best treatment for noxious weeds and fungous diseases have been published, at the time of their injurious occurrence, of such pests as have made themselves noticeable by their sudden appearance in injurious numbers. This has been either through the annual reports of the Experimental Farms, or of the Agricultural Committee of the House of Commons, in bulletins, or through the daily and agricultural press.

PUBLICATIONS.

The annual reports of the Division now contain fairly complete articles giving the history to date, with the remedies which have been found most effective, of many of the injurious insects of Canada.

Special bulletins also have been issued on the following subjects:

1888, No. 3.—The Smuts Affecting Wheat. In addition to this bulletin, further articles have appeared in more recent annual reports of the Experimental Farms.

1891, No. 11.—Recommendations for the Prevention of Damage by some Common Insects of the Farm, the Orchard, and the Garden. In this bulletin 37 of the worst pests are treated of.

1892, No. 14.—The Horn Fly, issued immediately on the first appearance of the insect in Canada.

1893, No. 19.—Grasses: their uses and composition, written jointly with Mr. F. T. Shutt.

1895, No. 23.—Fungous Diseases and Injurious Insects, written jointly with Mr. John Craig.

1897, No. 28.—Weeds: 164 troublesome plants are mentioned and described, together with the best way of fighting them.

1901, No. 37.—Apple Insects, a part of a bulletin on apple culture, by Mr. W. T. Macoun.

1903, No. 43.—Plum Insects, in Bulletin on Plum Culture by Mr. W. T. Macoun.

1904, No. 46.—Alfalfa or Lucerne: its culture, use and value, written jointly with Messrs. J. H. Grisdale and F. T. Shutt.

1905, No. 52.—Insects Injurious to Grain and Fodder Crops, Root Crops and Vegetables. Forty-five of the worst enemies of these crops are dealt with, and many are illustrated.

In addition to the above, two small bulletins for limited circulation, entitled, 'Experimental Farm Notes, No. 2, Potato Blights,' and No. 4, 'The Russian Thistle,' were issued from this Division in 1894. In 1895 reports on the Hop Aphis, the San

José Scale, and 'Investigations in Manitoba and British Columbia as Entomologist and Botanist,' were printed in the annual report of the Hon. Minister of Agriculture for 1895.

Since 1884, when the Select Committee appointed by the House of Commons to obtain information as to the agricultural interests of Canada met, the Entomologist has been invited annually to give evidence before the Committee on Agriculture and Colonization of the House of Commons, upon the most important occurrences of insects injurious to crops and the most recent developments in methods of fighting them, and also upon recent work with regard to grasses and other useful fodder plants. Reports of this evidence have been published regularly, and through the generosity of the Printing Committee have been supplied in such number, both in French and English, as to allow of their being sent to all of the regular correspondents of the Division. In this way a good opportunity has frequently been afforded of getting useful suggestions into the hands of farmers sooner than would be possible through the annual reports at the time they are usually issued.

USEFUL INVESTIGATIONS.

Among the investigations which have claimed the attention of the officials and with regard to which it is hoped that useful advice has been given to the farmers of Canada, mention may be made of the following subjects which have been studied for several years, and concerning which from time to time reports have been published. No lengthy reference is here made to those insects which have recently been treated of in Bulletin 52 on Insects which cause injury to Grain Crops, Roots and Vegetables. It may, however, be thought justifiable to point out, that through the persistent recommendations of this Division remedies for some of these which have saved many thousands of dollars to the farmers of Canada, have been made widely known and have been more generally used than might otherwise have been the case. In this category are the following which it is believed are, all things considerd, the best remedies for the different insects named:—

The Hessian Fly.—Late sowing, the burning of refuse from the threshing mills, and the burning over or deep ploughing down of stubbles.

The Joint-worms.—The burning over or deep ploughing of stubbles, burning refuse, and a regular rotation of crops.

The Greater Wheat-stem Maggot.—Late sowing. Trap crops sown in July and ploughed down in August.

Cutworms.—Clean farming, so as to destroy all weeds in autumn when the moths of many species lay their eggs. Poisoned bran-mash and poisoned baits. Special mention may be made of the former, a most useful remedy.

Grasshoppers or Locusts.—The Criddle mixture of fresh horse droppings poisoned with Paris green.

The Pea-weevil.—Systematic fumigation of all seed pease with bi-sulphide of carbon; treating the seed with coal-oil; holding over seed for two years.

The Clover-seed Midge.—Cutting or feeding off the first crop of clover to be saved for seed, by June 20.

Small White Cabbage Butterfly, the parent of the 'Cabbage-worm.'—Dusting cabbages, as soon as the caterpillars are seen to be destructive, with pyrethrum insect powder, 1 lb. in 4 lbs of flour or some other perfectly dry powder as a diluent.

Root Maggots of Radish and Onion.—Watering the young plants once a week from the time they appear above the ground with the Cook Carbolic wash. Dusting once a week with white hellebore or insect powder.

Root Maggots of the Cabbage.—Dusting or watering around the roots after uncovering them, with an infusion of pyrethrum or white hellebore, 1 oz. in a gallon of water, at time of transplanting and again a week later.

The Colorado Potato Beetle.—Spraying with the poisoned Bordeaux mixture for this insect, and for the Potato Rot at the same time, beginning in the first week of July and repeating three or four times.

The Cucumber and Potato Flea-beetle.—Spraying with the poisoned Bordeaux mixture.

The Turnip Aphis.—Hoeing out the colonies or spraying them as soon as they appear with Kerosene Emulsion.

The Turnip Flea-beetle.—Dusting the young plants when the beetles are seen to be abundant, with Paris Green 1 lb. in 50 lbs. of land plaster or some other dry powdery diluent. Deferring sowing turnips until the 15th or 20th June.

HISTORICAL RESUMÉ.

At the time the Division of Entomology and Botany was organized it was thought wise, for a short time at any rate, that the two subjects of Entomology and Botany should be entrusted to a single officer and the writer of this report was appointed to take charge of the work. As soon as circumstances allowed, a beginning was made in forming reference collections of insects and plants and the present collections of the Division have been gradually accumulated since that time. As a nucleus to both of these collections, the above named presented his private collections consisting of about three thousand species of Canadian plants and a general collection in all orders of insects. A beginning was made in preparing the Arboretum and Botanic Garden, at that time connected with this Division, for planting out, and also the land was got ready for the Experimental Grass Plots, which are now such an interesting feature of the Central Experimental Farm. During 1888 a large number of native plants and grasses were collected in the Ottawa District, seeds were procured from botanical gardens, botanists and seedsmen in all parts of the world, from which such were obtainable, and these were grown in seed beds for subsequent removal to the botanical garden or the ornamental grounds. In 1895 the practical work of the Arboretum and Botanic Garden was, at the request of the Entomologist and Botanist, transferred to the Horticultural Division, as was originally intended, and which was a much more convenient arrangement because Mr. W. T. Macoun, who was then Foreman of Forestry, had men under his control and was in a better position to look after the necessary labour, such as cultivating, planting, tidying up, &c., than was the case with the Botanist who had only one man whose time was fully occupied with the grass and fodder experiments.

In the first years of the farm work the insect enemies of the small grains demanded much attention and a great deal of work in connection with the life-histories of these insects was carried on and published in the annual reports. The enemies of fodder crops were also studied at that time and good service was done in making known the practical remedies for the Clover Seed Midge, the Pea Weevil, &c. Many growers followed the instructions given and reaped great advantage. The Turnip Flea-beetle was for a few years from 1887 till about 1890, a very serious pest of the turnip grower, two or three sowings being often necessary. After many experiments it was found that the loss could be saved by what have now become the standard remedies for this insect, viz.: dusting the young plants just after they come up with one pound of Paris green in 50 lbs. of land plaster, and the agricultural remedy of sowing at such date, about the middle of June, as will enable the young plant to make its true leaves in between the broods of the beetle. When sown too early or too late the seed leaves are destroyed to the great detriment of the crop.

Insects of the vegetable garden were also studied on account of the great losses due to the attacks of the White Cabbage Butterfly, root maggots, and various kinds of cutworms. Practical remedies for all of these by which enormous savings may be made have now been devised and are the common property of all who will consult the reports of the Experimental Farms and make use of the suggestions there given.

In 1889 the Mediterranean Flour Moth *(Ephestia kühniella,* Zell.) first appeared in Canada, the life history was worked out and the advantage of freezing the insects by opening the mills to the winter cold was pointed out among other remedies. This opportunity was made use of for publishing accounts of the other granary pests. In the same year Fuller's Rose Beetle (*Aramigus fulleri,* Horn.) was first discovered as a troublesome greenhouse pest in Canada.

In 1890 the present Experimental Plots for Grasses and Fodder-plants were laid out and all varieties of which the seeds were obtainable by collection, by correspondence, or by purchase, have been tested carefully as to their hardiness, crop-producing power, nutritive value and palatabilty to stock. Many hundreds of different fodder plants have been experimented with, and much valuable information has been given to the country through these experiments. The plots themselves are a constant source of interest to all visitors, and we are in a position from the results of our experience to give advice as to the best mixtures for hay, pasture and all other purposes for which grasses are grown.

In 1892 the Hop-vine Borer *(Gortyna immanis,* Gn.) did much harm in the hop fields of Prince Edward county, Ontario. The habits of the insect were worked out and published the same year, as well as those of the Red Turnip Beetle *(Entomoscelis adonidis,* Fab), which every year does some harm to cruciferous crops in the Prairie Provinces. The Birch Skeletonizer (*Bucculatrix Canadensisella,* Chamb.) was a conspicuous enemy of the birches all through Ontario for two or three years from 1892, and injured the trees considerably by destroying their foliage. About this time the imported Larch Saw-fly *(Nematus erichsonii,* Hartig.), which had appeared as a destructive forest insect in Canada in 1882, practically disappeared, from the fact that it had destroyed all the tamaracs of large size. In 1902 it again showed up, but in very small numbers, and has been noted every year since that date. In 1893 a collection of twenty cases of insects was sent from the Entomological Division to the World's Columbian Exhibition at Chicago, and attracted much attention. In the same year the first notable outbreak of the Black Vine-weevil as a crop pest in Canada occurred in British Columbia. This beetle *(Otiorhynchus sulcatus,* Fab.) seems to be a maritime species, as it has since that time been found a rather troublesome enemy of strawberries on our Pacific coast, and also in Nova Scotia. Recently the Sleepy Weevil (*Otiorhynchus ovatus,* L.) has added its injuries of the same plant to those of the above, attacking the roots in the same way. The Cattle Horn-fly, which showed itself first in Canada in 1892, was very detrimental to stock in Ontario in 1893.

In 1894 another change was made in the work of the Division by which the work on Fungous Diseases was transferred, in a large measure, to the Horticultural Division. As many experiments had been carried on by the Botanist in treating the destructive disease known as Potato Rot, this for a time was left with the Botanist, who demonstrated conclusively in exhibition plots at the Central Experimental Farm, that this disease could be practically prevented by spraying with the Bordeaux mixture, now in such general use for this purpose. This year saw also an outbreak of the Army-worm in northern Ontario. Severe attacks by some fruit insects also called for attention. The San José Scale was this year detected in British Columbia, but the occurrences were entirely wiped out by the destruction of the infested trees. The Cigar Case-bearer of the Apple *(Coleophora fletcherella,* Fernald) was studied and the species described. The Pear-tree Psylla (*Psylla pyricola,* Foerster) was destructive in the Hamilton district of Ontario, and the Peach Bark-borer (*Phlœotribus liminaris,* Harr.) in the Niagara district.

In 1894 the Apiary, which has been ably managed by Mr. John Fixter since it was instituted, was established, and from that time has been of much interest to bee-keepers, many of whom visit the Central Farm to consult Mr. Fixter.

Outbreaks of special note in 1895 were by the Cabbage and Turnip Aphis *(A. brassicæ,* Bouché), the Carrot Maggot *(Psila rosæ,* Fab.), which every year is destructive in the maritime provinces, and sometimes extends its work as far west as Ottawa, and the Joint-worm *(Isosoma hordei,* Harr.) in western Ontario. The Cottony Grass-

Scale (*Eriopeltis festucæ,* Fonsc.) was abundant in Nova Scotia. The Carpet Beetle or 'Buffalo Moth' (*Anthrenus scrophulariæ,* L.) called for attention as a household pest. It was first reported in this role in Canada in 1889.

1896 was another Army-worm year, this time in western Ontario. There were also widespread depredations on fodder crops by locusts or grasshoppers in many parts of the Dominion. Similar outbreaks had occurred in western Ontario in 1893, and on Sable Island in 1895. The injurious species were in each case the Red-legged Locust (*Melanoplus femur-rubrum,* DeG.), the Lesser Migratory Locust (*M. atlanis,* Riley), and the Two-striped Locust (*M. bivittatus,* Say.).

The first record of the Apple Maggot in Canada was made in this year at Adolphustown in Lennox county, Ontario, and an insect which injures the apple in a very similar manner (*Argyresthia conjugella,* Z.) was abundant in Vancouver island and the lower mainland of British Columbia.

In 1897 fruit insects were the chief objects of study. The San José Scale may be said to have begun its injurious work in Ontario orchards in this year, and great efforts were made to prepare our fruit-growers to recognize it, to appreciate the danger of neglecting it, and in pointing out the best known means of control. The Currant Maggot (*Epochra Canadensis,* Loew.) was also dealt with.

1898 was marked as the first year of a rather serious outbreak of the Rocky Mountain Locust in Manitoba, which lasted until 1904, and was the cause of much loss in central Manitoba. The outcome of this occurrence, however, was the discovery of the useful Criddle mixture by Mr. Norman Criddle, of Aweme, Man., which has been of great use in controlling these very destructive insects. The Lesser Apple-worm (*Enarmonia prunivora,* Walsh) was destructive in British Columbia orchards, and much harm was done by the two common species of Tent Caterpillars in Ontario. This was chiefly to forest trees.

The season of 1899 was signalized by an extensive destruction of the pea crops all through the older provinces by the Destructive Pea Aphis (*Nectarophora destructor,* Jnsn.) This is supposed to be identical with a species which sometimes attacks clover. The Asparagus beetles (*Crioceris asparagi,,* L., and *C. 12-punctata,* L.) also added themselves to the pests of the Canadian market gardener in this year. They have done some harm in the south-western counties of Ontario ever since.

In 1900 began a period of very severe injury to the fall wheat crop of western Ontario by the Hessian Fly, which lasted for two years, and another old-time enemy, the Pea-weevil (*Bruchus pisorum,* L.) was so abundant as to cause some growers to relinquish the cultivation of this useful pulse. The attacks of this latter were much intensified by extensive injury by the Pea Moth (*Semasia nigricana,* Steph.) Perhaps the most remarkable outbreaks of the year were by two cutworms, the Variegated Cutworm (*Peridroma saucia,* Hbn.) in British Columbia, and the Spotted Cutworm (*Noctua c-nigrum* L.) in Ontario.

In 1901 two new enemies, the Potato-stalk Weevil (*Trichobaris trinotata,* Say.) and the Grape-vine Colaspis (*Colaspis brunnea,* Fab.) were added to the Canadian list, but the injury was not serious by either of them.

In 1902 the first serious injury by the Hessian Fly to spring wheat in Manitoba occurred, but the same season saw its almost entire disappearance from the fall wheat crop of Ontario. Injury by the Pea-weevil was again excessive in Ontario and special efforts were made by the Division to stir up pea-growers to united action in fighting this destructive enemy. The seed pease were fumigated by all the leading seedsmen and in 1903 there was a most noticeable diminution in the numbers of the Pea-weevil. This improvement has continued up to the present time.

In 1904 there were no new attacks of importance. The cause of the greatest loss to farmers, brought to the notice of the Division was by a widespread epidemic of the Black Stem-Rust in the large wheat crop of the Prairie Provinces. There were also more severe losses from cutworms in some districts than is usually the case. The efficacy of the Poisoned Bran-mash for field practice on a large scale was amply proved.

The Wheat Midge *(Diplosis tritici,* Kirby) destroyed much of the wheat crop of the lower Fraser country in British Columbia; but wheat is not an important crop in that district.

The Plum Curculio *(Conotrachelus nenuphar,* Hbst.) made serious inroads into the sparse crop of plums of Ontario. A firmly established colony of the Apple Maggot was found in the important apple-growing locality of Como in the province of Quebec. The most effective treatment to control this insect was made known to the growers, and it is hoped that before long a decided improvement in conditions may be noted.

On Vancouver Island, the Vancouver Island Oak-Looper *(Therina somniaria,* Hulst), an insect of periodic occurrence did much harm to the beautiful oaks around Victoria.

In 1905 the most important reduction to the crops of the Dominion was in the enormous wheat crop of the west. This was due to a severe outbreak of Bunt or Stinking Smut. In the eastern provinces some injury was caused to various crops by the caterpillar of a noctuid moth, called in my last report, the Armed Rustic *(Barathra occidentata,* Grt.) I am told, however, by Sir George Hampson, of the British Museum, that the species is really *B. curialis,* Sm.

There were a few instances of injurious presence of insect enemies of forest and shade trees in 1905. In the Ottawa district the native Arbor-vitæs or White Cedars were much disfigured by the minute larvæ of a species of Tineid moth (*Argyresthia thuiella,* Busck) which bore in the tips of the twigs and cause them to die and turn brown. The Spruce Gall-louse *(Chermes abietis,* L.) was frequently complained of from many points in Ontario, and the first Canadian specimens of the Larch Case-bearer (*Coleophora laricella,* Hbn.), which often does much harm in Germany, were found at Ottawa.

In the Division of Botany the most important work of the officers has been in connection with testing the suitability of various fodder plants for profitable cultivation in Canada, and in giving information concerning noxious weeds. The most valuable outcome of the first line of this work, has undoubtedly been the introduction into American agriculture of the two valuable grasses, the Awnless Brome-grass (*Bromus inermis,* Leyss.) from Russia, and the Western Rye-grass *(Agropyrum tenerum,* Vasey), a native Canadian grass first cultivated as a crop by Mr. K. McIver, of Virden, Man.

Noxious weeds have been made a subject of special study by the Botanist for many years, and the exceptional opportunities he has had of visiting all parts of Canada, attending meetings and of spending several weeks in the West for many years, driving through the country, holding meetings and visiting farmers, have enabled him to learn much of the nature and distribution of most of the different weeds which give farmers trouble in the various parts of the Dominion. Several articles on weeds have from time to time been printed in the reports, and a large correspondence on the subject is constantly carried on as to the best way to treat these pests of the farm, and also as to the names of strange seeds found in samples of crop seeds sold by seedsmen or saved by farmers themselves. When the Seed Selection Special train, which for two months traversed all the western lines of railways in the winter of 1905-6, was planned, the Botanist was invited to take part in this work. This he was able to do, and delivered 145 addresses upon the subjects of weeds and their eradication, and on the smuts of the small grains. The following notice was prepared for *The Farmers' Advocate,* and appeared in their issue of April 12, 1906:—

'THE WORK OF THE SEED SELECTION SPECIAL TRAIN.

'During January and February of this year an important experiment was tried in the prairie provinces, the results of which must surely bring great benefit to the farmers of the west. For many years it has been known that smut was causing considerable loss among the small grain crops in that part of Canada, and although some of the more advanced farmers every year treated their grain to protect themselves against this loss, many others did not. As the crop of 1905 came under inspection in

Winnipeg on its way to the lake front for shipment, it was found that an alarming amount of the wheat was contaminated with smut, or with the seeds of weeds. In 1903 the percentage of dockage and rejection was only 3 per cent; in 1904 this had run up to 5½ per cent, or nearly double; but in the crop of 1905 a far worse state of affairs was manifested, and it is probable that upwards of 20 per cent of the enormous crop for the year, of nearly 90 million bushels of wheat, will be graded as "rejected" by the official inspectors. It was thought that something could and should at once be done to improve this state of affairs. The Canadian Pacific Railway and the Dominion Department of Agriculture consulted together, and invited other influential bodies to join them in a special campaign, the aim of which was to remind farmers before the spring work began, that more care was necessary than had evidently been shown in preparing their seed grain and caring for the resulting crop. Mr. W. B. Lanigan, of the Canadian Pacific Railway, and Mr. G. H. Clark, of the Dominion Seed Branch of the Department of Agriculture, were the two leading spirits in this work. The Canadian Pacific Railway provided the train, in which the speakers lived entirely during the two months of the campaign, and hauled it over all their lines. The Canadian Northern co-operated with the Canadian Pacific, and all the chief places along both of these railways in the West were visited.

'The lecturers were for the most part officials of the Dominion Department of Agriculture, and all were under the direction of Mr. Clark, the energetic Chief of the Seed Division at Ottawa. Mr. Angus Mackay and Mr. S. A. Bedford, of Brandont, the well-known and highly esteemed Superintendents of the Western Experimental Farms, gave most valuable assistance, as also did Mr. T. N. Willing, the Chief Weed Inspector for the province of Saskatchewan, who probably has a wider and more exact knowledge of the weeds of the West than any one else. Messrs. James Murray, W. C. McKillican and the writer, all members of the Dominion Department of Agriculture, also took part in this important work.

'The Grain Growers' Association of Manitoba and the Northwest Territories were represented by their head officials. The Hon. W. R. Motherwell, the Minister of Agriculture for Saskatchewan, who is also president of the Northwest Grain Growers' Association, and Messrs. McCuaig, Henders and McKenzie, of the Manitoba Grain Growers' Association, showed their sympathy with the movement, by accompanying the train for the greater part of the time, and delivered many valuable addresses. Mr. John Mooney, of Valley River, Man., a practical farmer and an expert breeder of pure grain, and Mr. A. Mitchell, Weed Inspector for the province of Alberta, spoke on seed selection and seed testing.

'The campaign lasted for two months, in which time 206 meetings were held, which were attended in all by 28,910 people. A noticeable feature of this campaign was that the railways did their work well, arriving at the advertised points promptly in almost every instance. The speakers showed that they knew thoroughly the subjects they were dealing with, and the audiences were invariably appreciative and sympathetic, listening patiently and asking many useful questions concerning those subjects of the greatest local interest. Notwithstanding the low temperatures which prevailed during part of January, the lecture cars were always well filled, many farmers driving in to the meetings from ten to twenty miles. The audiences frequently expressed their satisfaction with what they had heard, and the only regrets voiced were that the meetings could not be longer, and that more places could not be visited. For the most part there were two lecturers in each car, and the subjects dealt with were practically the same at each place visited, except that prominence was given to the subjects or the weeds which were known to be of greatest interest in each place. At the close of each meeting the visitors were handed some specially-prepared pamphlets, in which the subjects dealt with by the lecturers were also treated of in a concise way, and they were requested to take these home and to discuss them with their friends.

'It was distinctly stated that no effort was being made to teach the farmers of the West anything new, but simply to remind them that the public records which were appearing in the daily newspapers of the inspections of the wheat going forward

showed the existence of an alarming state of affairs, from the number of cars which were being marked "rejected," and further, that this was from causes which could to a large measure be prevented. These causes suggested the subjects treated of, which were as follows:—

'1. Seed Selection by Fanning Mills.—It was pointed out how much could be done by using the fanning mill thoroughly, to blow out all small and broken grains which produce weak, late-maturing plants, and that good plump seed would give strong plants, which would produce a regular and uniform crop. Lack of vigour in the plants made them susceptible to injury from fungous diseases and insect pests.

'2. Seed Selection in the Field.—It was advised to select every year some large heads of grain from fully-ripened plants, true to a desired type and variety, and to use these for a breeding plot or base of supply for pure seed, thus increasing the yield and improving the quality of the grain. As illustrating the practicability of this measure, it was pointed out that all the millions of bushels of Red Fife wheat now cultivated in the West originated from a single plant found by Mr. David Fife in a field of wheat near Jermyn, Peterborough county, Ontario, in 1842, and also that during the present year a farmer at Moose Jaw had offered for sale 3,000 bushels of a selected strain of wheat, all of which was the product of a single head of wheat selected five years ago.

'3. Seed-testing for Vitality.—Many samples were exhibited, showing how difficult it is to know from the appearance of grain what its germinating value is. Some samples, which looked very nearly as good as others which germinated 100 per cent, when tested showed only a germinating power of from 50 to 60 per cent, proving conclusively that if a farmer were to sow such grain without testing it for vitality, he would require to sow nearly double the amount of seed to get a stand for a crop. The simplicity with which grain could be tested was shown by samples of grain which had been sprouted between the folds of a damp cloth placed between two tin dishes to retain the moisture. It was advised to pick out at random just 100 grains from the seed which had been put by for sowing. The cleanness and fascination of this work commended itself particularly to the wives and the children of farmers, who could thus, while contributing to their own pleasure, also do something of great benefit to the whole family.

'An equally simple and rather better experiment was also shown, of placing the hundred grains in a box of soil, which could be kept in any warm room in the house, and would in a few days show not only how many seeds would germinate, but also the comparative vigour of the young plants.

'4. Treatment of Seed Grain to Prevent Smut.—Smut, the fungous disease which is responsible for by far the greater proportion of loss in last year's crop, was specially dealt with. The nature of the disease was explained and the remedies which had given the best results were recommended, together with the simplest way of applying them. It is well known by farmers in the West that bluestone or formalin are practical remedies for treating seed grain before sowing, so as to destroy the adhering smut spores. This may be done by dipping seed in a solution of 1 lb. of bluestone in 8 gallons of rain water, or by sprinkling the same over the grain and turning it over thoroughly with a shovel until every grain is wet. It is best to sow as soon as convenient after the seed is dry, but the work may be done at any time when convenient after the middle of March. Ten gallons of solution will treat 8 bushels of oats or 10 bushels of wheat. Instead of the above, commercial formalin may be used, ½ oz. in each gallon of water; 1 lb. of formalin in 32 gallons of water will treat 27 bushels of oats or 32 bushels of wheat. Bluestone and formalin are equally good for wheat, but formalin is much better for oats and barley. After treating with formalin, the seed grain should be heaped up and covered for a few hours with sacks or blankets, to keep the fumes in.

'Some of the worst weeds were dealt with in detail, and it was pointed out that even the worst weeds could be controlled if their nature were considered. Farmers were recommended to give this matter special consideration. It was claimed that

there were only eight or ten weeds which were noticeably destructive in any one locality, and that if the nature of these were borne in mind the work of destroying them would be much simpler.

'Special instructions were given for the eradication of wild oats, stinkweed, perennial or field sow thistle and Canada thistle. Particular stress was laid on the value of harrowing, or using a weeder on growing crops for the destruction of the seedlings of all annual weeds while they were small and easily killed. Grain crops should only be harrowed when the land is in proper condition for harrowing, and not before the young grain is three inches high.

JAS. FLETCHER,
'Entomologist and Botanist.'

OFFICIALS OF THE DIVISION.

The staff of the Division of Entomology and Botany consists of the following in addition to the writer, who has held office since July 1, 1887.

J. A. Guignard, B.A., Assistant Entomologist and Botanist, and Curator of the Botanical Collections; appointed April 11, 1892.

Arthur Gibson, Assistant Entomologist and Curator of Insects; appointed April 1, 1899.

Berthold Nothnagel, in charge of the Experimental Grass Plots since 1890.

SPRAYING WITH ARSENITES.

At the time the Experimental Farm system was organized, the words 'spraying' and 'spraying pump' were actually unknown as the names of a method and implement for distributing poisonous liquids in a fine state of division to protect plants against parasitic enemies. Largely through the work of this Division, the benefits of this work have been made known and insisted upon, even at times against outspoken and inexplicable opposition by men holding prominent places among fruit-growers and farmers. The only explanation which can be offered is that such opposition was simply a protest against adopting any new method, as a regular part of the annual work, which involves so much extra labour beyond what up to that time had been found necessary. Undoubtedly one of the most important discoveries which has ever been made in practical entomology and horticulture is the utility of the arsenites as destroyers of leaf-eating insects. This, added to the invention of the spraying nozzle, largely through the skill of Dr. Riley and his assistants in the Division of Entomology of the United States Department of Agriculture at Washington, have provided fruit-growers and others with a reliable remedy, and an implement with which to apply it, in the most economical and at the same time safe manner. Of recent years there have been many variations and some improvements in the remedies suggested for injurious insects, and also in the manufacture of spraying pumps and nozzles, but on the whole, if used with proper care, nothing has been yet brought forward of greater general utility and safety than Paris green. Similarly, the Riley Cyclone nozzle, with the Vermorel improvement of a disgorger to clear any obstruction from the orifice, is to-day the best nozzle obtainable to produce what this operation demands, the breaking up of the liquid to be applied into such a fine state of division as to be an actual spray. It cannot be insisted on too strongly that, to get the best results in spraying, such force and such nozzles must be used as will break up the liquid so thoroughly that it falls upon the plants treated as an actual mist. Such terms as 'sprinkling' and 'showering' are inaccurate for the operation here intended. Unfortunately much of the so-called spraying as usually carried out could more accurately be designated by these terms, which describe a much less careful and less even distribution of the liquids, and consequently one which is far less effective in attaining the ends aimed at in spraying. The chief factors which affect the utility of spraying as an agricultural and horticultural operation are (1) lack of knowledge on the part of the operator as to what is

required; (2) lack of pressure or too large an orifice in the nozzle used, so that the liquid is not broken up into a mist; (3) badly working pumps, which increase the labour so that the work becomes irksome, and is done in a slovenly manner, and (4) lack of care in doing the work thoroughly and in following instructions as to methods and formulæ given by those who have made a business of testing the best remedies for the pests to be controlled. The efforts of specialists have been directed towards one or two main objects in devising formulæ to be used against injurious insects and fungi. In the first place, the remedy must be effective so as to destroy the pest without injuring the crop; it must be easy of application and manufacture, or the work will be done improperly, and it must be economical so that the cost and labour involved in using it may be commensurate with the increased profits secured by the operation.

During the last twenty years so much excellent work has been done in studying the life-histories of injurious insects and fungous diseases, that at the present time any farmer in Canada or the United States who finds his crops being injured by pests of any kind, can within a short time, by applying to the government bureaus of information, get at once advice by which in almost every instance he can prevent a very large and paying percentage of loss. Of recent years it has been found that some of the standard remedies for both plants and insects may be combined and applied at the same time. A notable instance of this is found in the poisoned Bordeaux mixture, made of the two standard remedies for leaf-eating insects and surface fungous diseases, viz.: Paris green and Bordeaux mixture. Very soon after this remedy was made known, experiments were tried, in 1887, by the Entomologist and Botanist as to its efficacy in destroying insect enemies of potatoes and at the same time the destructive fungous disease, Potato Rot. This whole matter was treated at length, after several careful experiments, in the annual report of the Entomologist and Botanist for 1892, and since that time has been found by all who have tried it and have done the work carefully, to be a paying and reliable means of protecting their crop against considerable loss, and also of increasing the yields to a remarkable extent. This work is now carried on every year on an extended scale by the Horticulturist of the Central Experimental Farm, who has of recent years published many convincing proofs of its utility.

Spraying fruit trees and potato crops with the poisoned Bordeaux mixture three or four times every year at stated times, varying slightly according to the species for which remedies are required, should now be recognized as part of the regular routine of the season. This is being done by all leading growers who have recognized that it is a paying operation, and have made provision for it in counting the cost of growing their crops. Spraying, properly done, is the most effective and economical method of applying remedies, but to do the work well it is neither easy nor is it a cheap operation, but in every instance where done as recommended through the publications of the Experimental Farms, it is an operation which pays handsomely, and is therefore worthy of attention by all who grow crops for profit. Spraying carelessly done is gross extravagance. It is an expensive operation both in labour and in materials. The decided increase in quantity and quality of the crop reaped make this expenditure worth while; but if the work is done improperly, little or no results follow, and much additional expense has been incurred. A very marked result of careful spraying practised for several years, is the cumulative effect of this continued protection of the crops. Of later years it has been a rare occurrence to find in the regularly sprayed fruit orchard at the Central Experimental Farm any serious injury by insects or fungous diseases, while in an orchard of seedlings where little spraying is done, Codling moth, Borers and Bud-moth occur sometimes abundantly.

Of the active poisons which are used as insecticides and which can be distributed over trees and crops by means of a spraying pump, the various compounds containing arsenic have by far the widest range of usefulness.

Arsenites.—The best known of these are Paris green, Arsenate of lead and Arsenite of lime with soda, which has lately come into very much more general use.

In all these poisons, arsenic is the essential ingredient, and other chemicals are mixed with the arsenic for the purpose of preventing it from injuring vegetation. There are many spraying compounds which contain arsenic, some of which are sold ready-made, and many others are made at home by combining the necessary ingredients.

Paris Green.—Undoubtedly the best known, and in many respects the safest, poison to use is Paris green. It has passed through many years of trial, is well known, has a distinctive colour, and is a definite chemical compound containing 58·65 per cent of arsenious oxide, 31·29 per cent of copper oxide, and 10·06 per cent of acetic acid. It is, therefore, an aceto-arsenite of copper. It is soluble in ammonia. Paris green, if demanded, is now obtainable pure in all parts of Canada; but, as there is sometimes an adulterated article found in the market, it is wisest always to add an equal amount, with the Paris green, of freshly slaked lime, when the free arsenic will combine with the lime, and it can then be used safely at the rate of one pound of Paris green in 160 gallons of water on all vegetation, and, for a dry application, 1 pound of Paris green in 50 pounds of flour, land-plaster, slaked lime or some other perfectly dry powder.

As a general principle, lime should be always used with Paris green whenever it is applied in a liquid insecticide. Paris green is very heavy, and the particles quickly sink to the bottom of any liquid with which it is mixed. This makes constant stirring necessary. Paris green does not dissolve in water, and is merely mixed with water to facilitate its even distribution on vegetation in the very small quantities that are necessary to destroy insects. The finer the poison is ground the quicker its effect on the insects which eat it, because the minute crystals are more rapidly dissolved by the digestive juices in the stomachs of the insects. The finer it is ground the better also it will remain suspended in a liquid application. For most insects, one ounce of Paris green in 10 gallons of water is the standard strength; but some plants with coarse foliage, such as the potato, will stand double that strength.

Arsenate of Lead.—A poison which has come into much notice since the work of the Massachusetts Gypsy Moth Commission is Arsenate of Lead, which has been placed on the market in a very convenient form under the name of Bowker's Disparene and of Swift's Arsenate of Lead. The chief advantages of Arsenate of Lead are that it can be applied to all kinds of foliage with less danger of injury than is the case with Paris green; and, on account of its fine state of division, it lasts longer on the foliage, because it does not wash off so easily. The cost of using it is about the same as that of Paris green, because, although cheaper, pound for pound, it is necessary to use three times the amount of it to get the same results. Arsenate of Lead may be made at home. Formulæ for its preparation vary slightly; but in the United States Division of Entomology, Bulletin No. 41, the following instructions are given for making the Arsenate of Lead wash ready for use:—

Arsenate of soda	10 ounces.
Acetate of lead	24 "
Water	150 to 200 gallons.

The arsenate of soda and acetate of lead should be dissolved separately and then poured into a tank containing the required amount of water. These chemicals unite readily, forming a white flocculent precipitate of lead arsenate, which is easily kept in suspension and can be used in excessive strengths on delicate plants without the addition of lime. When sprayed upon the foliage, it forms a filmy adhering coat, which is but little affected by ordinary rains.

Another formula for making Arsenate of Lead is that recommended by Prof. H. T. Fernald, and is :

Arsenate of soda, 50 per cent. strength	4 ounces.
Acetate of lead	11 "
Water	150 gallons.

Put the arsenate of soda in two quarts of water in a wooden pail, and the acetate of lead in four quarts of water in another wooden pail. When both are dissolved, mix with the rest of the water. Warm water in the pails will hasten the process. Prof. Fernald recommends that in mixing this with Bordeaux mixture one gallon of the above should be mixed with fifty gallons of the mixture.

'*Arsenite of Lime and Soda:*—

White arsenic	1 pound.
Sal soda (crystal)	4 pounds.
Water	1 gallon.

'The ingredients are boiled in the required amount of water until dissolved, which will take place in a comparatively few minutes, after which the water lost by evaporation is replaced. To every 40 or 50 gallons of water, a pint of this stock solution and from 2 to 4 pounds of fresh slaked lime are added. The chemical compound derived from the combination of the sal soda and the white arsenic is arsenite of soda. In the presence of lime this breaks down and arsenite of lime is formed. It requires 4·4 pounds of crystal sal soda, or 1·6 pounds of dry sal soda to combine with one pound of arsenic, and 2 pounds of freshly slaked lime to combine with one pound of arsenic to form arsenite of lime. It is always desirable to have an excess of lime present, in order to prevent all danger of burning; furthermore, this excess is a convenience to fruit growers, because they can see by the distribution and amount of lime on the foliage how well the spraying has been done. The formula, which is the Kedzie formula with a few minor changes, has been used in many different sections of the country with unvarying success. In all of the practical tests under the advice of the writer, this solution is used and is found to be, not only as efficient as other solutions, but far cheaper.

'When it is desired to use Bordeaux mixture with this solution, it is added to the lime Bordeaux mixture in the same proportion as to a similar quantity of water.'—(*C. B. Simpson, Bull. 41, U.S. Div. Ent.*)

Some Best Remedies.

The large amount of attention which of recent years has been given to insects which attack crops of various kinds has led to much experimenting as to the best remedies. What the best remedies are will vary to a certain extent with local conditions and the financial circumstances of the operator. Upon crops of small area it is not always expedient to purchase expensive implements, although these are nearly always the best, and all that is aimed at in the following notes is to give in concise form those remedies which we have found most effective and the most practical for general recommendation. Large commercial fruit growers and agriculturists have, of necessity, learnt in carrying on their business, which machines give the best results; but there is a constant demand from fruit growers and farmers of small holdings for information as to what we have found to be the best remedies. It must be remembered, however, that what may be the best remedy with some operators is not necessarily so with others. Care in carrying out instructions, in making up formulæ, and in applying remedies, vary so much with different individuals, that care is one of the most important factors in deciding which remedy is the best under special circumstances.

As stated above, the insects which attack field crops and vegetables have recently been treated of in Bulletin 52, issued in June, 1905. The following references are to insects which do harm to other crops.

The Codling Moth (*Carpocapsa pomonella,* L.).—This well known insect which every year reduces so materially the profits of those apple growers who do not spray regularly, is now found in almost every part of the world where the apple is cultivated. The perfect insect, a beautiful little brown and gray moth, barely half an inch in length by ⅝th of an inch in width when the wings are closed, is very seldom seen

on account of its nocturnal and secretive habits. The white or pinkish caterpillars, ¾ of an inch in length, which feed in the heart of apples of all kinds are far better known, and under the name of 'Apple worm' are recognized by all fruit growers. The eggs are laid upon the outside of young apples about a week after the blossoms fall and also upon the foliage. These eggs are flat, like a very small fish's scale, and are very inconspicuous. The eggs hatch in about a week and the young caterpillars find their way into the fruit through the calyx or upper end. They feed for a few days on the outside of the apple or inside the calyx. This gives an apportunity of destroying them by spraying the trees with poisonous mixtures. In Canada east of a point about Toronto there is only one regular annual brood of the Codling moth, and the insect can then be controlled almost entirely with careful and regular spraying with the poisoned Bordeaux mixture. West of Toronto there are two broods, the second of which is by far the more destructive and difficult to cope with. It has been found that in this latter district it is necessary to supplement the spring spraying by wrapping the trees with loose bands of burlap or some other material which will serve as a refuge in which the caterpillars will spin their cocoons, these to be removed at short intervals after the middle of July, when the caterpillars begin to spin up. Care must be taken to scrape or brush the bark beneath these bands with a stiff brush or some other implement so as to remove all of the cocoons which are frequently sunk into the substance of the bark by the caterpillars gnawing away the surface. The insects in the bands may be killed by dropping the latter into boiling water or by crushing the cocoons. The poisoned Bordeaux mixture made with 4 lbs. of fresh lime, 4 lbs. bluestone and 4 ounces of Paris green, in 40 gallons of water, we have found to be a sure remedy against the Codling moth, if applied every year. Three applications are necessary, the first one applied a week after the blossoms have fallen, and the others afterwards at intervals of fifteen days. In orchards which have not been previously treated for a year or two, four sprayings should be given.

The Plum Curculio *(Conotrachelus nenuphar,* Herbst.).—One of the worst enemies of the fruit-grower is only too well known under the name of the Plum Curculio. The female lays her eggs in the flesh of plums and apples when these are about as large as pease. The female makes a characteristic mark, which is shaped like a crescent, and almost surrounds a little flap cut out of the side of the fruit, and in which the single egg will be found. Although called the Plum Curculio this insect is frequently a serious enemy of the apple, particularly in orchards which are grown in sod. Occasionally whole crops will be ruined and drop from the trees in the end of June. Owing to what is known as the June drop, by which the overplus of young apples beyond what the trees can mature properly, drop from the trees in the end of June or the beginning of July, this injury to apples is frequently overlooked by fruit-growers, but by cutting into the apple the inside will be found to be burrowed in every direction and to contain two or three dirty white grubs with brown heads, about a quarter of an inch in length. The perfect beetle is a weevil with its mouth parts at the end of an elongated beak. It is less than a quarter of an inch in length, brown and rough with black and grey mottlings, which give it a remarkable resemblance to a small piece of bark and make it difficult to distinguish. There is only one brood in the year, but perfect beetles may be found at all times. The beetles of the summer brood emerge during August or September of one year, pass the winter as perfect insects under dead leaves, &c., and feed on the leaves and buds of plum trees early in spring. Later in the year they attack the leaves and fruits of various kinds, and the old insects of the year before may often be collected with those of the newly-emerged brood. The peach, apricot, cherry, apple and pear are all injured by the Plum Curculio. The injury to plums is most conspicuous because they fall from the trees soon after the grub begins to bore through them. Apples also fall in large numbers when there are several grubs. The peach, apricot and cherry do not fall to any extent. By midsummer the grubs are full grown and then burrow a short distance into the ground, where they turn to pupæ.

Remedies.—The remedies for the Plum Curculio are as follows: (1.) Spraying the trees early in the season so as to destroy the beetles which for some time feed upon the buds and opening leaves of plum trees. The second spraying, with poisoned Bordeaux mixture, should be made when the plums are about as large as pease. This will coat the young fruit so that the beetles are destroyed when they feed on the fruit or cut the crescents for egg laying. (2.) The destruction of all windfalls or injured fruit that drops, so as to clear away all fruit before the larvæ emerge and enter the ground to pupate. Poultry, pigs and sheep help well in this work. (3.) The ploughing up and cultivation of orchards so as to remove grass and other vegetation which, besides weakening the trees, gives places for the insects to hide in. The depth at which the larvæ pupate is about an inch beneath the surface, and the pupation in this part of Canada takes place during July; therefore cultivation during that month will destroy many of the pupæ, and this has been found the remedy which has given the best results in old orchards which had been in sod for many years and in which the fruit had been seriously injured year after year. (4.) The jarring of plum trees, which is much written about and highly recommended, will certainly destroy many of the beetles, but costs too much for labour when compared with spraying with insecticides, which give more certain results in my experience. As the plum and peach are rather easily injured by some arsenical poisons, arsenate of lead, 1 lb. to 50 gallons, is preferable to Paris green for these trees.

The Apple Maggot (*Rhagioletis pomonella,* Walsh).—This insect, also known as 'the railroad worm,' has been the cause of much loss in the apple orchards of Vermont, Maine, and parts of New York State, just south of our borders. There have also been one or two rather serious outbreaks in Canada. The injury is caused by slender white maggots about a quarter of an inch in length, which burrow in all directions through the flesh of the apple, feeding upon the pulp and leaving discoloured channels. There are sometimes as many as a dozen maggots in a single apple, but even a single one is sufficient to render it worthless for the market. The eggs are inserted beneath the skin of the fruit by prettily marked little black and white flies with shining golden eyes. They are less than half the size of the ordinary housefly, and are very active. There is only one brood in the year, but the flies appear very irregularly, being found on the trees laying their eggs from the beginning of July until autumn. The young maggots become full-grown in about six weeks, and their presence as a rule causes early fruit to ripen prematurely and fall to the ground when the maggots leave it and enter the soil for a short distance. There they change to white puparia, inside which they remain as maggots until the next summer. The pupa forms only a short time before the perfect insect appears. The maggots of late-laid eggs are frequently inside the fruit at the time it is picked, and these go on developing and destroying the fruit more and more as they grow. Apples, apparently sound when gathered, may afterwards become perfectly useless. All varieties of apple are liable to attack, but early varieties seem to be preferred by this insect.

Remedies.—The only practical remedy so far known, but one which has given excellent results, is to destroy all infested fruit as soon as this fact is discernible. Wind-falls particularly should be carefully gathered up during the summer and fed to stock or destroyed in some other way. The most economical and effective way of doing this is, perhaps, to allow pigs to run in the orchard from July when early apples, which are specially susceptible to attack, begin to fall, and till all fruit is gathered. Sheep will eat apples if there is not too much grass on the ground, but are less useful for this purpose than pigs. Chickens and other poultry are likewise of service. The ground under apple trees in districts where the apple maggot is known to occur should not be left in sod, but should be cultivated regularly. The fruit of seedlings, crabs and lightly esteemed varieties which are sometimes left unpicked in an orchard should all be attended to and either picked or threshed from the trees and destroyed. If there is no stock available to which this fruit can be fed, it should be buried in a deep hole and then covered up with no less than two or three feet of earth.

There is no spraying mixture which can be used against this pest because the eggs are inserted into the flesh of the fruit by the females with their sharp ovipositors.

San José Scale *(Aspidiotus perniciosus,* Comstk.).—There are few insects which have caused so much loss where they have established themselves as the now notorious San José Scale. So much has been written about it that it is now pretty well known, not only by its work upon trees, but also by its appearance to fruit growers in the small corner of Ontario where only in Canada it is found in injurious numbers.

Two small colonies were found in British Columbia last year, but were promptly dealt with, and it is believed that they are now wiped out. The minute, almost circular, scales, one-thirteenth of an inch wide, shaped like an inverted saucer, with a depressed ring around a central point, are sufficiently different from other scales to be recognized at sight after a little experience. One very good diagnostic character for the young scales which are found on nursery stock in winter is the black or dark coloured hue inside the ring. One of the great dangers of this insect is that when only in small numbers it is so inconspicuous that it is easily overlooked, and should this happen, its enormous powers of increase during a summer, when press of work as a rule prevents fruit-growers from examining their trees very carefully, enable it to increase sufficiently to do serious harm and spread to many other trees.

Remedy.—Frequent inquiries are made as to whether there is a practical remedy for the San José Scale. I believe that it may now be justly claimed that the lime and sulphur wash made by any of the recognized formulæ is a reliable remedy for this insect. Orchards which have been carefully treated are in better condition than they were a year or two ago, and have borne during the past summer satisfactory and profitable crops of fruit. No remedy, however perfect it may be, will give good results unless great care is taken in applying it; even with the lime and sulphur wash, it is not claimed that a single application will always give perfect results. Any remedy which does not cost too much for labour and materials, and which will ensure a paying crop, is certainly a practical remedy. All remedies will vary in the degree to which they secure the ends aimed at, and all that is claimed for the lime and sulphur wash for the San José Scale is that up to the present, all things considered, this has proved the best remedy, and is, at any rate, as successful in its results as any known remedy which is used in medicine for controlling the diseases of animals or human beings. Success with any remedial treatment will necessarily always depend on the thoroughness with which it is carried out.

The Canadian wash is made by mixing lime and sulphur together in the proportion of twice as much lime as sulphur, and boiling these together in an iron kettle for two hours (or not less than one hour). The quantity of water added to make up the required amount of wash is largely a matter of convenience in using. When boiled with steam, barrels may be used, and to begin with, should be one-quarter filled with water and the steam turned on until the water is boiling; then turn off the steam and put in the lime and sulphur together as quickly as this can be done without making the mixture boil over. When the lime is all slaked, turn on the steam again, and leave the mixture boiling for at least an hour.

Oyster-Shell Scale (*Mytilaspis ulmi,* L.).—This well-known and destructive enemy of fruit trees, particularly of the apple, has now been complained of from almost every part of Canada where fruit trees are grown. There is only one brood of the Oyster-shell Scale in the year. The young bark lice emerge from beneath the old mother scales in Ontario and British Columbia about the end of May, and in the Maritime Provinces towards the end of June. At that time they are small six-legged insects resembling mites. After emerging they wander about the trees for a few hours, looking for a suitable place to attach themselves to the bark, which they do by means of their slender beaks. Trees upon which this insect occurs are weakened by being robbed of their sap by these insects. Frequently the scales occur in such enormous numbers as to almost coat the trees and entirely hide the bark. In southwestern Ontario excellent

work has been done in preventing the spread of this scale insect, by a minute chalcid parasite, *Aphelinus mytilaspidis*, Le Baron. It is bright yellow in colour with golden eyes and measures only about one thirty-sixth of an inch in length; being so small it can hardly be seen with the naked eye. The parasite is sometimes so abundant that it destroys more than half of the scales that are formed. Its presence on an infested tree can be detected by the small round holes made through the scales when the flies emerge.

Remedies.—Although so destructive in all parts of Canada, the Oyster-shell Scale is not a particularly hard insect to control, where trees are attended to regularly. The first step to take when an orchard is found to be attacked is to invigorate the trees by ploughing round them and feeding them with some quick-acting fertilizer, such as well-rotted manure, or a dresing of wood ashes. When trees have been standing in sod, it is well to break this up. Trees which are planted too closely, should be pruned and cleaned out, so that they may be easy of access for spraying and other operations. As soon as winter has set in, the trees should be sprayed thoroughly with a thin lime wash, one pound of lime in each gallon of water. Two coats must be applied, the second immediately after the first is dry. Where the lime-sulphur-and-salt wash is used to protect trees against fungous and insect enemies, there will never be any trouble with the Oyster-shell Scale. The young bark-lice emerge from their mothers' scales about June; the exact date should be watched for, and, immediately the dust-like yellow mites are noticed, the trees should be sprayed without delay with weak kerosene emulsion, or a whale-oil soap solution, using one pound to six gallons of water.

Pear-Leaf Blister Mite (*Phytoptus pyri,* Nalepa).—A considerable amount of injury is done every year in all parts of Canada, where the pear is grown, by the operations of the Pear-leaf Blister-mite. The irregular blotches about one-eighth of an inch in diameter and frequently confluent, caused by these mites are frequently so abundant on the foliage as to make it impossible for the leaves to perform their functions. These blotches when examined are found to be hollow blister-like galls with a hole in the centre through which large numbers of almost invisibly small mites issue and attack fresh parts of the leaf. Few people recognize this injury as the work of an insect at first sight. It is nearly always sent in as a fungous disease, but if one of these galls is cut open and examined with a strong magnifying glass it is easy to detect the white elongated mites with which the inside is filled. The remedy for this insect enemy is to spray the trees just before the leaf-buds expand with the lime and sulphur wash. The sulphur is practically obnoxious to all kinds of mites, and it has been found that this serious enemy of the pear-grower may be practically exterminated with a single thorough spraying with the mixture above mentioned.

Canker worms.—Slender brown or green loopers, or 'measuring worms,' about an inch in length when full grown, and with only six pairs of legs, three pairs of which are on the front part of the body and the others close to the other end, causing the caterpillars when they walk to raise the central portion into a loop. These are the caterpillars of two kinds of geometrid moths which lay their eggs on the trees in the autumn in one species, and in the spring in the other. The injury done by these caterpillars is sometimes serious and where neglected they increase so much in infested orchards that sometimes the greater part of the foliage may be destroyed before they are noticed.

The remedy is to spray the trees as soon as the young caterpillars appear. After they have become half grown they require much stronger poisons to kill them than many other insects. When they have been neglected it is perhaps better to use arsenate of lead than Paris green and as much as a pound of the poison may be used to 50 gallons of water or Bordeaux mixture.. As the females are wingless and crawl up from the ground to deposit their eggs on the trees, many may be prevented from egg-laying by mechanical contrivances or they may be caught on bands of thick paper painted with a mixture of castor oil, two pounds and resin, three pounds, for cold weather, but in hot weather it is necessary to add one more pound of resin. These are heated slowly until the resin is all melted and the mixture is applied to the bands while it is warm.

Another formula is 5 lbs. of resin and 3 lbs. of castor oil for warm weather and equal parts by weight for cold weather. The most convenient way to apply these mixtures is to paint them on to bands of thick paper, but they may be applied to the tree without injury. It is sometimes necessary to put on a second coating if too much of the oil is absorbed by the bark. Printer's ink, 5 lbs. mixed with 1 gallon of fish oil is also very much used in Nova Scotia and the amount mentioned will treat an acre of orchard.

The Eye-spotted bud-moth (*Tmetocera ocellana,* Schif.)—The Eye-spotted Bud-moth has been so abundant during the past two years that there is an unusual amount of inquiry concerning its habits. There is only one brood in the year. The inconspicuous moths, dark gray in colour blotched with white, may be found at rest on the trunks of trees from the middle of June until the middle of July. They become active at night flying about fruit trees of various kinds, laying their curious little flat eggs upon the leaves. Ten days after the eggs are laid the small caterpillars crawl to the middle of the lower side of the leaf and form a silken tube close to one of the larger ribs. Here they feed on the tissues of the lower side of the leaf and grow very slowly until autumn, remaining all the time on the leaf where they were born. About September they stop feeding and crawl to the twigs where they spin a close silken shelter in which they pass the winter and from which they emerge early the next spring and, compared with their size, do an immense amount of harm by attacking the unfolding buds, frequently destroying a whole bunch of blossoms and sometimes two or three. The best remedy is to spray the trees thoroughly with a poisoned Bordeaux mixture at the time the buds are opening, covering the whole tree so that every bud receives some of the poison. Experiments having in view the destruction of the young caterpillars in the autumn were not very successful. It is difficult to find time to spray during the fruit season and this of course would be unwise upon bearing trees. The experiments referred to were upon early apples of which the fruit had all been picked some time before. If it is considered too much trouble to use Bordeaux mixture for the first spraying at the time the buds are bursting, a simple Paris green mixture which is more easily made, consisting of one pound of Paris green, one pound of fresh lime, and 100 gallons of water may be used.

The Cattle Horn-fly *(Hæmatobia serrata,* Desv.).—This troublesome pest of horned stock, which appeared first in Canada in 1892, has done much harm by irritating cattle with its bites so that when it is abundant they fall off rapidly both in flesh and in yield of milk. From the time it first appeared in Canada this fly has spread over all parts of the Dominion, reaching the Pacific coast in 1903; but is by far more troublesome in the eastern provinces than in the west. The fly is a small and very active dark gray species about one-third the size of the ordinary cattle fly, and shaped just like that insect with the same kind of biting, dagger-shaped beak, carried projecting forward in front of the head. When in large numbers these flies frequently cluster on the horns to rest. It was from this habit that they got their name. Statements that they bore holes into the horns are inaccurate. The only harm done by them is due to their very irritating bites on the bodies of the animals. The eggs are laid by the females in freshly deposited cow droppings. The maggots hatch in 24 hours and become full grown in about a week; they then burrow down a short distance into the ground and turn to brown puparia, from which the flies emerge in four or five days. There are several broods during the summer, and the last brood of maggots passes the winter as puparia.

Remedies.—Of the many remedies we have tried, the following have given the greatest satisfaction: (1) smearing the parts most usually bitten with a mixture of lard, 5 lbs., and pine tar, 1 lb. Two applications each week when the flies are very bad. Mix well together and apply to the parts most attacked, brushing the mixture lightly over the tips of the hair. After two or three applications the treatment has more effect than at first. (2) Spraying the animals twice a week with ordinary kero-

sene emulsion. (3) Fish oil 2 quarts, and oil of tar, 2 oz., or fish oil, 2 quarts, coal oil, 1 pint, and oil of tar, 2 ozs. (4) Good work may be done by breaking up the cow droppings in the field. The maggots can only live in the dung while it is in a moist condition. A boy with a rake could go over a pasture three times a week and break up all the fresh droppings and the drying up of these by the sun or the washing away by rain would kill all the eggs or maggots, thus locally reducing the numbers very much.

Cattle Lice.—The loss from these disgusting and very common parasites of horned stock is far greater than is generally appreciated. Many animals turned out in spring in poor condition have been reduced in flesh by the constant discomfort of being preyed upon by myriads of lice which might have been destroyed by a little attention on the part of those in charge of them. On account of the small size of lice they are often overlooked until they have become very numerous and have done a great deal of harm. Lousy animals will neither rest nor feed well. They are prevented from putting on flesh, their growth is stunted, and their meat is neither so good nor produced so economically. It is well known that an animal kept in good condition and steadily increasing in weight costs much less to prepare for the market than one whose growth is checked and allowed to get into poor condition. Lice cause more loss in stock than is generally appreciated. This loss is unnecessary because all of the common external parasites of live stock can be easily and cheaply treated. There are two kinds of lice found commonly on cattle, the Small Blue Louse or Biting Ox-louse (*Trichodectes scalaris,* Nitzsch) and the Big Black Louse or Short-nosed Ox-louse *(Hæmatopinus eurysternus,* Nitzsch). Both of these parasites are sometimes found in great numbers on neglected cattle, and when the stalls have become thoroughly infested are hard to clear out entirely; but this can be done by continued effort and with great benefit to the stock and to the owner. Many remedies are known. We have used kerosene emulsion with much satisfaction, spraying it on to the animals and then rubbing it well in with the hands. Any of the recognized sheep dips will also answer, and are very convenient. Recently Zenoleum has been used for this purpose and answers well. All of the latter are used of the strength advised by the makers. An important part of the treatment consists of spraying thoroughly the stalls where the animals have stood, after cleaning them out. Both of these lice leave the animals and hide in the cracks and crevices of the woodwork.

Hog Louse (*Hæmatopinus suis,* Leach).—This is the largest louse known, measuring one-quarter of an inch in length. It is of a dirty white colour marked with brown. The feet are provided with strong claws with which they cling tightly to the hairs. Although from the nature of the animals they infest and the usual way their pens are built, these lice are rather difficult to eradicate, the same remedies mentioned for the cattle lice will quickly and entirely kill these parasites also, as I have found on several occasions. It is necessary to spray the sleeping quarters very thoroughly.

Sheep Louse (*Trichodectes sphærocephalus,* Nitzsch).—This is a very small louse but is a very troublesome parasite, causing great irritation to infested animals which show their discomfort by rubbing themselves and by biting at the wool. Most of the severest cases of infestation by sheep lice have been in the winter. Sheep should be examined before winter sets in and if any lice are found they should be dipped.

The Sheep Tick *(Melophagus ovinus,* L.).—Although usually known as the Sheep Tick this is not a true tick, all of which in the mature form possess eight legs, but is a true six-legged insect. It is in fact a member of the lowest-developed section of the Diptera or Flies. It belongs to the Louse-flies or Hippoboscidæ. All of the members of this small division are very abnormal both as to form and mode of reproduction. They are all parasites living on birds and animals. Some are winged as those often found on hawks, but the so-called Sheep Tick is wingless. Instead of laying eggs the louse-flies retain the larvæ inside the bodies of the females until they are full grown, only one

developing at a time; they then emerge and at once turn to brown puparia, which are attached to the wool of the sheep by a sticky secretion. From this the fully developed parasite emerges and at once attacks its host. Each female produces only four or five young, and these are born one at a time. Notwithstanding this, Sheep Ticks are frequently very numerous on a single animal. The bite causes much irritation and when they infest lambs they do much harm sometimes even causing death. There should be no trouble with either Sheep Lice or Sheep Ticks if the animals are regularly and properly dipped in spring soon after shearing. The work must be done thoroughly. Kerosene emulsion answers admirably; but commercial dips are as a rule thought to be more convenient because they can be purchased ready made, requiring only to be mixed with the prescribed amount of water. For dipping, a deep vat is generally used and care must be taken that the animal, head and all, is pushed right under the liquid. Poisonous dips should not be used either for sheep or for cattle. For this reason the kerosene emulsion is preferable to many other dips which are sometimes used.

REPORT OF THE CEREALIST.

CHARLES E. SAUNDERS, B.A., PH. D.

OTTAWA, March 31st, 1906.

Dr. WM. SAUNDERS, C.M.G.,
Director Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to submit herewith a report of the work of the Cereal Division.

As the period to be covered by this report is only from November 30th, 1905, to March 31st, 1906, and as most of the experiments carried on in this division can only be satisfactorily presented when the work of a full year is being considered, it seemed best, under the circumstances, to give, instead of the details of the winter's work, a brief statement in regard to the experiments carried on since the establishment of the Cereal Division, as well as a short review of the chief features of the work of earlier years.

I have the honour to be, sir,
Your obedient servant,
CHARLES E. SAUNDERS,
Cerealist.

ESTABLISHMENT OF THE CEREAL DIVISION.

Though only recently organized into a separate division, the work of testing and breeding cereals has been carried on ever since the Dominion Experimental Farms were established.

For the first sixteen years this work was under the immediate care of the Director, but during the latter part of that period it was found increasingly difficult for him to give a sufficient amount of time to the experimental work with cereals. In the year 1903, therefore the Hon. Minister of Agriculture appointed a new officer to take charge of this branch of experimental inquiry, and to devote the whole of his time to it.

IMPORTATION OF CEREALS FOR EXPERIMENTAL PURPOSES.

The original stocks of seed grain for the commencement of the experimental work on the farms were obtained from many different sources. Varieties of wheat were secured through the London (Eng.) Corn Exchange. Direct importations were also made from Russia, France and Germany, and some very interesting cereals of early ripening character were obtained from India through the assistance of the Earl of Dufferin, then Viceroy of India. Many varieties of grain were also obtained from some of the experimental stations in the United States and from seedsmen and farmers in Canada and elsewhere.

In this way many different sorts of seed were brought together for comparative test, the object in view being to determine the relative value of the different sorts in

yield, earliness, strength of straw, quality of grain, &c., when grown close together under conditions as nearly uniform as possible.

The importation of foreign grains did not cease, however, when the system of test-plots was well established. Many new sorts have since been obtained from various sources from time to time. Among these are a few very interesting varieties which may prove of value. As a rule, however, it appears that better success will be obtained by breeding our own sorts than by importing varieties bred in other countries under climatic conditions usually quite different from those of Canada.

IMPORTATION OF LARGE LOTS OF GRAIN.

In addition to the small quantities of grain imported from various countries for test on the experimental farms, much larger lots were purchased in two instances in the effort to meet at once certain special difficulties. The importations referred to were those of Ladoga wheat and of English Two-row barley.

The early settlers in some districts of the Northwest Territories sometimes suffered a considerable reduction in the value of their wheat crop because of early autumn frosts which occurred before the grain was quite ripe. It was, therefore, felt to be of great importance to secure for those districts a variety of wheat which would ripen about a week earlier than Red Fife (the kind most commonly grown). A quantity of seed wheat was, therefore, obtained from Northern Russia, from near Lake Ladoga. This variety was a promising, hard red wheat to which the name Ladoga was given. The grain was supplied for seed purposes to farmers living at a number of different points in the Northwest. It proved to be considerably earlier in ripening than Red Fife and gave good yields, but when at length a sufficient quantity was obtained for a milling and baking test (which at that time required a large amount of grain) the flour was found to be too yellow in colour for the public taste, and was also somewhat different in other respects from that made from Red Fife wheat. The cultivation of Ladoga wheat was therefore not further encouraged, except in the sections of country farthest north where the Red Fife was quite unsuitable, and where all the wheat grown was used for home consumption.

In the year 1890 an effort was made to encourage Canadian farmers to grow barley for export for malting purposes to Great Britain and Ireland, tariff charges in the United States having deprived our country of a market for a considerable quantity of barley. Six-row barley had been grown for export to the United States, but as the English market required two-row barley a quantity of seed of a suitable variety was obtained from England and sold to farmers so that they might be able to start at once the growing of comparatively large quantities of one of the best English malting sorts.

The results of this experiment showed that first-class barley of the type desired by the English buyer could be produced in many districts in Canada. It was found, however, that our system of shipping grain in bulk made it impossible, as a rule, to retain the identity of the finest samples, which usually become mixed with poorer grain before reaching the purchaser. This and other circumstances almost completely stopped the exportation of barley; and while this grain is still largely grown in Canada, it is now used for feeding purposes at home, to the greater advantage of the farmer.

TEST PLOTS OF CEREALS.

The system of uniform test plots which was established early in the history of the experimental farms has proved of great value in enabling us to reach conclusions as to the relative merits of the different varieties of grain. The size of the plots has been changed somewhat from time to time, but of late years the standard has been one-fortieth of an acre. Smaller plots than this are not very satisfactory for cereals,

and larger plots are scarcely practicable at the Central Experimental Farm. The number of varieties tested in these plots since the commencement of the work has been very large, and has included all the important commercial sorts obtainable as well as a great number of cross-bred varieties and selected strains produced at this farm. Most of the kinds which have proved distinctly inferior to the others have been rejected after a few years' trial so that the work might be kept within reasonable bounds. These systematic tests have not only given valuable information in regard to the varieties in general cultivation, but have also made it possible for us to select for distribution among farmers the very best from among the newly produced sorts.

In order to present to the farmers in as useful a form as possible some of the most important conclusions drawn from these comparative tests of cereals, short lists of the varieties recommended for general cultivation (and sometimes those required for special purposes also) are published each year in the annual report.

EARLY SOWING OF CEREALS.

An extensive series of tests, completed several years ago, showed that in the climate of Ottawa it is of the utmost importance to sow all cereals early, in most cases about as soon as the land can be brought into proper condition to receive the seed. Quite a noticeable reduction in yield occurs if the seeding is delayed a week, and there is usually a very serious loss if the delay is of two weeks' duration.

The best time for sowing cereals on this farm is from about April 20th to 26th in an ordinary season.

QUANTITY OF SEED TO USE PER ACRE.

Experiments are in progress to determine the best quantity of seed to sow per acre in the case of wheat, oats and barley. The tests are being made both on heavy and on light soil. The results vary somewhat from season to season, so that the tests may have to be continued for some years yet before entirely satisfactory conclusions can be reached.

BREEDING NEW VARIETIES OF GRAIN.

The crossing of different varieties of wheat, oats, barley and peas for the production of new sorts specially adapted to Canadian conditions was undertaken as soon as possible after the establishment of the Experimental Farms. It was recognized that cross-breeding was the only method of work likely to produce varieties combining those qualities necessary for the greatest success.

Among the first crosses made were some between Red Fife wheat and Ladoga and between White Fife and Ladoga. In both of these experiments the object in view was to combine the high quality of the Fife wheat with the earliness of the Ladoga. Several new varieties were produced from these crosses, and the best sorts have been distributed under the names Preston, Stanley, Huron and Percy. All of these are vigorous varieties, ripening as a rule about a week before Red Fife. As the distribution of these varieties was begun before they were fully fixed in type they are not altogether of uniform character as now found in commerce. Recently, however, they were all carefully re-selected, and fixed strains of distinct character and improved quality are now being grown at the Central Experimental Farm. The best of these will be distributed to farmers as soon as possible.

Many other crosses were made, during the first few years of the existence of the Experimental Farms, in wheat, oats, barley and peas, some of which have proved very

interesting, though they have not attracted so much attention as the varieties already referred to.

When the work in cereals was organized into a separate division, the cross-breeding was at once taken up in a much larger way, and the systematic selection of existing varieties by the newer method of choosing single plants was begun. The selection of single plants of great excellence as the starting point of each new strain has been found greatly superior to any of the older methods of selection whether of best heads or of best seed from a number of similar plants. Several hundred cross-bred kernels have been produced during the last three years, and these seeds have already given rise to many thousand new varieties, most of which have, of course, been rejected, only the best being retained for further test.

In all the work of crossing and selection of cereals the chief points aimed at are to increase the productiveness, earliness, quality of grain, strength of straw, ability to resist rust, &c., and to produce varieties suitable for the various soils and climates of the different sections of Canada.

Among the new sorts now on hand, in very small quantities, of course, there are many which show great promise. Some of the extremely early wheats which ripen two weeks before Red Fife and produce hard red kernels of excellent milling quality, will no doubt prove very useful in the northern sections of our great wheat-growing provinces, and will also be found valuable for rather cold and damp soils in districts farther south. Nearly all of the very early wheats produced thus far have rather short straw, a distinct advantage for some situations. Among the early sorts, ripening between those just mentioned and Red Fife, there are some vigorous varieties which give promise of great productiveness, and which produce straw of good length. Some of these may be of much value in rather poor soils, or in districts where the rainfall is deficient.

In barley and oats many new sorts are being produced, special attention being paid to the hulless and beardless kinds and to those varieties of very early maturing habit.

Many new cross-bred sorts of peas are also under trial, including some very promising varieties of the crown type bearing coloured (instead of the usual white) flowers.

MILLING AND BAKING TESTS OF WHEAT.

As has already been pointed out, it was not possible until a few years ago to have a satisfactory test of the value of any wheat for flour-making and bread-making until quite a large quantity of the grain was available. It was, therefore necessary to introduce a variety before its quality could be ascertained. Now, however, since the small experimental flour mills have been manufactured, it is possible to make satisfactory milling and baking tests from a very small quantity of wheat. The purchase of a small mill and of the necessary baking apparatus has added a most important new feature to the work of the Cereal Division, and has greatly increased the possibilities of doing good service for the country. All the new varieties produced at this farm are now subjected to milling and baking tests before being distributed to farmers for trial. This system has made it possible to eliminate some undesirable new sorts which, though very promising in most respects, were found, to be deficient in flour strength for bread-making.

While chiefly designed for testing new varieties of wheat produced at this farm or imported from abroad, the experimental flour mill has also been employed in the study of some of the more common commercial varieties and grades of wheat. Bulletin No. 50 of the Experimental Farm series gives the results of a study of the milling and chemical value of the grades of wheat in the Manitoba Inspection Division (crop of 1904). This investigation was carried on by the Cereal and Chemical Divisions together.

Other tests of a somewhat similar nature have been made. Red Fife and White Fife were carefully compared, and it was shown that there seemed to be no ground for the common idea that White Fife (in pure condition) is inferior in quality to Red Fife.

The inferiority of Club wheat was clearly demonstrated, and the western farmers were strongly advised to discontinue the cultivation of this variety on account of the poor quality of the flour it produced.

During the present winter several interesting varieties are being tested, and the difference between very hard and very soft Red Fife (both samples being known to be quite true to name) is being studied. The results thus far obtained show clearly that the flour from very soft Red Fife has markedly less strength, for baking purposes, than that obtained from very hard Red Fife. The two samples compared were both grown in the same district of Manitoba, but on different kinds of soil.

This investigation into the quality of wheats is intended to include all the leading sorts of both spring and winter wheats now grown in Canada. It is believed that many farmers pay too little attention to the quality of the varieties they grow, and that in many instances it will be found practicable to substitute superior sorts for those which are now being cultivated. At present, however, the information obtainable by farmers in regard to the quality of the leading sorts of wheat is very meagre.

FIELD ROOTS, INDIAN CORN, ETC.

In addition to cereals the experimental investigations in regard to field roots, Indian corn for ensilage, millets and some other fodder crops are carried on by the Cereal Division. Comparative tests of different varieties cannot be conducted quite so satisfactorily with these crops as with cereals, owing to the difficulty of procuring from year to year exactly the same strains of seed. The seed cannot, as a rule, be advantageously ripened on this farm, but is purchased every year from various seedsmen. The diversity of names given to essentially the same seed when sold by different firms also complicates the work considerably.

The importance of early sowing and of late pulling for roots have both been well established by tests covering a number of years. So far as weight of crop is concerned, there is a decided gain in sowing the seed as early and leaving the roots in the soil as late as can safely be done.

REPORT OF THE POULTRY MANAGER.

A. G. GILBERT.

OTTAWA, March 31st, 1906.

Dr. WM. SAUNDERS, C.M.G.
Director Dominion Experimental Farms,
Ottawa.

SIR,—I have the pleasure of transmitting to you an interim report covering a period of four months from November 30 to March 31.

In this report methods of feeding and management, which many years of experience have proved to be effective in the obtaining of eggs and poultry, at the best paying seasons of the year, are described and discussed.

It is hoped that the more general practice of these methods by the farmers of the country will enable them to successfully cater to the requirements of a rapidly growing market for the better quality of poultry and eggs.

I have the honour to be, sir,
Your obedient servant,

A. G. GILBERT.

THE WORK OF THE POULTRY DIVISION.

Since the date of the first annual report of the poultry divison of the Central Experimental Farm, nineteen years ago, there has been a marked and gratifying change in the attitude of the farmers of the country to the poultry branch of their farms. It is not very long ago that the fowls on the farm were looked upon as a non-paying quantity and received scant attention. If the adult birds received little attention, the newly hatched chickens, when they came, usually late in the season, received still less. They were allowed to 'pick up their own living' and to thrive as best they could. As a result, the lean, sinewy and scraggy chicken was the rule, rather than the exception, on the markets. New laid eggs were scarce and high in price. They are yet high in value, but from a different cause. Then they were high in price because scarce. To-day they are equally high for the reason that the demand for them is greater than the supply, although the latter has greatly increased. The scraggy chicken has, to a great extent, given place to the well fed and cared for specimen of correct market type. Customers are more inclined to pay a better price for a better quality, and producers find it most profitable to cater to the more exacting demand with articles of the best quality. Indeed the best class of customers to-day will have none other.

INCREASING DEMAND FOR NEW LAID EGGS IN WINTER.

Another feature of poultry development worth noting is the increasing demand for strictly fresh eggs in winter. This was strikingly shown by the high prices which prevailed in this and other cities of the Dominion during the months of November, December, January and February last, when from 35 to 50 cents per dozen was paid

by leading grocers for the strictly fresh article. And this, despite the fact that the past winter of 1905-06 was unusually mild. Prices remained high until the beginning of March, when they declined owing to the arrival of fresh laid eggs from the country. The following values were obtained by our poultry division for strictly new laid eggs during the months named. These prices were the same as paid to producers by the leading family grocery stores of the city, viz.:—

August, 1905	20	cents per dozen.
September, 1905	25	"
October, 1905	30	"
November, 1905	35	"
December, 1905	50	"
January, 1906	50	"
February, 1906	40	"
March, 1906	25	"

At the close of the last named month the eggs were sold for hatching at $1 per setting and their disposal for eating purposes ceased to a very great extent.

WHAT EXPERIENCE HAS SHOWN.

Experience has clearly shown that extra care and attention are necessary before the strictly new laid and well flavoured egg, or, plump chicken of proper type can be placed in the hands of the purchaser. It is well that farmers and other producers should realize that, neither 'select' eggs nor 'superior quality of poultry,' can be produced by the hap-hazard methods which were so prevalent in past years and are yet too common in many parts of the country.

That farmers and other egg producers are conforming in greater numbers, to these more exacting requirements, is indicated by the increasing demand for information in regard to them. The nature of these requirements and how to meet them are fully outlined in report of this department for last year, 1905, to which the reader is referred. Experience has also taught that to have winter eggs of freshness and fine flavour, they should be—

1. Non-fertilized.
2. Laid by well and cleanly fed hens.
3. After being laid they should be immediately placed in a cool sweet smelling cellar, or, cupboard.
4. They should reach the consumer as soon after being laid as possible. Certainly within one week or ten days.

HOW THE FINER QUALITY OF POULTRY MAY BE HAD.

To have the better quality of poultry the following conditions should be conformed with:—

1. The chickens should be of Plymouth Rock, Wyandotte, Orpington, or Dorking type.
2. The aim should be to have the frame of the birds as small-boned as possible, so that the weight of the chickens, when sold, will be in flesh rather than bone. This may be accomplished by breeding from the best market types only.
3. In order to have chickens in the most desirable condition, at the earliest age, it is requisite that they be well cared for and regularly fed from their earliest age.

Experience of many years has shown that if chickens are well looked after and of the proper type described, that very little, if any, fleshing by crate, or other means, is required to have them in acceptable condition at 3½, 4 or 5 months of age.

A DETRIMENTAL PRACTICE.

A practice not infrequently indulged in by farmers is certainly detrimental to their obtaining the highest figures. It is that of holding back their eggs until a sufficient number is collected to make it worth while taking them to city or town. In this way a large part of the eggs are stale before they leave the farm. The clerk in store and many of the purchasers on the market are well aware of this state of affairs and govern their valuation of the eggs accordingly.

On one occasion, during a recent winter month, the writer was present in a leading grocery store of the city, when a farmer entered and asked one of the clerks "if they were buying eggs?" The following conversation then occurred:—

CLERK.—How many eggs have you for sale?

FARMER.—Ten dozen.

CLERK.—How many eggs did you bring in?

FARMER.—Twenty dozen. I have sold ten.

CLERK.—How many months old are the eggs?

FARMER (indignantly).—They are not months old. They are fresh.

CLERK.—How many hens have you?

The farmer told the clerk, who immediately offered a price 15 cents below the value of the 'strictly new laid' article. The price was accepted. In this case the clerk evidently reasoned that if a small number of the farmer's fowls had been layers, some time must have elapsed before twenty dozen eggs could have been gathered up. As a result the eggs first collected would be a stale commodity and a price was named accordingly. On the other hand, it is not always convenient and ofttimes impossible for farmers, who live at a distance from city, or town markets, to make special trips to them, with only a few dozen eggs. Hence, the waiting until such a quantity of farm produce is got together as to make its disposal worth while. Such cases are frequently to be met with. They also show one cause why new laid eggs, during the winter months, are not likely to beach the city markets in over-abundance for some time to come. Farmers, who are located near city markets, undoubtedly have the best opportunities to receive the highest prices for winter eggs and the superior quality of poultry.

WHO OBTAIN THE HIGH PRICES.

In report of last year several letters from farmers are given to show the prices received by them for new-laid eggs and the finer quality of poultry. But farmers are not alone producers of fresh eggs and chickens of the better quality. The different producers may be thus classified:—

1. Farmers who are located in the neighbourhood of cities and large towns and who can readily reach purchasers who pay the best prices for the best goods.

2. Farmers within easy reach of express offices from which eggs may be shipped. The cost of eggs by express has increased from two cents per dozen to three cents. Crates, as heretofore, are returned free.

3. Specialists, amateurs, &c., who live in the suburbs of the city or town. Some of the latter class are expert enough to have their hens lay well in the winter months. They make it a feature to sell to only those who pay the highest prices.

AN UNWARRANTED OPINION DONE AWAY WITH.

In the earlier days of poultry keeping in this country there was a popular opinion, among farmers and many other poultry keepers, that in order to have eggs and poultry flesh, in quantity and quality, it was necessary to keep two different varieties of fowls, one to lay eggs only and another to furnish the proper type of market chickens. But experimental work has unmistakably made plain that egg-laying qualities and correct

market type could be had in the different varieties of Plymouth Rocks, Wyandottes, Dorkings and comparatively later comers in the Buff Orpington family.

Experience has also shown that laying qualities are more a matter of strain than breed; that the best known breeds, embrace in their many varieties good and bad egg-laying strains; that the selection of the best layers of the best market types of the breeds hitherto regarded as being good for flesh only and breeding from them, is the way to secure the desirable egg layer and market type combined. As a certain means to this end came the trap nest which with mechanical certainty makes known the history of each fowl in a breeding pen as a good layer or otherwise. So, to-day, we have strains of Plymouth Rocks, Wyandottes, &c., &c., which are as good layers as any of the famous egg-laying Spanish family, besides giving us chickens of the most desirable market sorts.

QUESTIONS WHICH ARE FREQUENTLY ASKED.

The following questions on subjects affecting the proper management of poultry are asked almost daily. They are given with replies to them on the present occasion, with the hope that their publication will anticipate inquiry on the part of many others:—

Q. What has experimental work shown to be fowls best adapted to the wants of the farmers?

A. Barred Plymouth Rocks, White Wyandottes or Buff Orpingtons. For the reason that they are excellent egg layers and their offspring are good table birds.

Q. What profit should hens pay per head per year?

A. Properly managed fowls should pay from one to two dollars per year each, over cost of keeping them. See statements made by farmers and others in C. E. F. Report for 1905.

Q. What is meant by the term 'dual purpose' as applied to a fowl?

A. By 'dual purpose' is meant a fowl which is a good egg-layer and of correct market type. She is a good layer of eggs in winter and her offspring like herself are of correct market types. The term 'utility' is also used to describe this kind of fowl.

Q. What is meant by strain?

Answer.—Strain is the development by careful selection and breeding of the best points of merit of each variety.

Question.—How is the moulting of the hens in summer brought on and how long does it last?

Answer.—The summer moult usually lasts from eight to twelve weeks. Mr. James Shackleton, a well known authority contends that by feeding specially prepared rations this period may be shortened. The following treatment has been successful in our department for several years. During the early part of July—after the breeding season is over—the fowls were placed on half the usual quantity of rations for 15 or 20 days. The effect of this treatment was the stoppage of egg production and the loosening of the old feathers. At end of 15 or 20 days the full rations were resumed. A little linseed meal may be added to the mash with benefit on the resumption of full rations. Before the beginning of operations to bring on the moult the cock birds were removed from the breeding pens and placed in compartments by themselves. The hens were then allowed to run in small fields where they could find insect life, clover, grass, &c. For description of 'full rations' see formula of winter egg producing ration on a following page. In the feeding of the fowls during moult care should be observed that they do not become too fat. The fowls are more apt to become over-fat, from too generous feeding during the moult than after they have got over it and recommenced laying.

Question.—What number of fowls should a farmer keep?

Answer.—Not more than he can profitably manage, say from 50 to 250, according to circumstances.

Question.—What number of chickens should a farmer hatch and rear?

Answer.—If hens are used as hatching mediums, from 50 to 100. If incubator and brooders, from 150 to 250. Much depends upon his liking for and knowledge of the work and the time at his disposal. Whether hatched by incubator or hens he should have all his chickens, if at all possible, hatched by end of the first or second week of May, so that the pullets will be early layers and the spare cockerels ready for early market.

Question.—What are the best methods of operation of an incubator and brooder?

Answer.—Full instructions accompany each incubator and brooder. Any deviation from these instructions is at the risk of the operator.

Question.—What are the prices of incubators and brooders?

Answer.—From $10 to $29 for incubators of from 60 to 240 eggs capacity. Larger machines are higher in price. Brooders range from $5 to $15, according to size.

Question.—Can turkey, geese and duck eggs be hatched in incubators?

Answer.—Yes, particularly duck eggs.

Question.—Will you name a ration suitable for egg production in winter?

Answer.—The following ration has been used in our department with great success for several years, viz.:

Morning.—Wheat, sometimes buckwheat, in proportion of 8 to 10 pounds to 100 fowls. Scatter in the litter on the floor of house or scratching shed attachment.

11 a.m.—Steamed lawn clippings, or clover hay, three or four times per week.

Noon.—If found necessary, oats in proportion of 5 lbs. to 100 hens. Scatter in litter on the floor to keep the fowls busy.

Afternoon.—Mash, composed of such ground grains as are in most abundance. Feed in quantity of 3 or 4 ounces to each fowl. When mixing the mash add a small teaspoonful of salt, and another of black pepper, or ground ginger. Occasionally mix boiled potatoes or turnips in the mash.

Cut green bone or other form of meat should be given in the proportion of one pound to 15 fowls, three or four times per week, in lieu of the steamed lawn clippings, clover hay or noon ration.

It is requisite for the good health of the fowls and to prevent egg eating and feather picking that the rations should be varied and regularly fed. Grit, mangels, turnips or other form of vegetable food should be in regular supply.

Question.—Will you name a ration that will successfully bring young chickens from hatching to marketable age?

Answer.—The following will be found effective:—First day—Little or no food is required. Towards end of the day a few stale bread crumbs may be fed. Second day—Stale bread soaked in milk and squeezed dry may be given in small quantity. Feed a little at a time and leave none on the platform. A little hard boiled egg finely cut up may be added with benefit. Continue this for a day or two and add granulated oatmeal; finely crushed wheat may be given at this time. Continue the stale bread soaked in milk and granulated oatmeal for ten days, when finely crushed corn may be added to the foregoing with advantage. After 14 days give whole wheat in small quantity at first. As the chicks grow older they should be given a mash composed of stale bread, shorts, cornmeal, ground meat, &c. Finely cut bone or meat will be found a great incentive to growth at this stage. On the chickens becoming eight weeks of age their rations may be dropped to three per day. Care should be taken that they are generously fed at last ration. For drink give skimmed milk and water.

When fully feathered the mothers of the hen-hatched chickens should be removed from them. The chickens will be found to return to their coops as usual, and they are allowed to remain in them until removed to more commodious quarters in colony houses. On the incubator-hatched chickens becoming too large for the brooders they were also removed to colony houses.

WINTER LAYING.

Winter laying commenced early in the month of December and continued during the winter season. Different rations were fed to fowls of different breeds, and the trap nests proved valuable in distinguishing the good from the bad layers.

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